THE

ELECTRICAL REVIEW.

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THE

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THE CHOICE OF A BOILER.

FEW things are more objectionable than a highly economical boiler which is always being laid off for repairs or cleaning. Thus the *Engineer* in an article on the choice of a boiler. Our contemporary puts first in importance the quality of the water as a factor in determining the class of boiler to be adopted at any given place, and no doubt there is very much to be said for this. Mere salesmen present to steam users all kinds of fallacious arguments when trying to get boilers sold. One man claims a large heating surface, another the number of tubes, the third the very small amount of water and the consequent quick steaming, as though the water contents made any difference at all when once steam is up. Between the many conflicting claims a non-technical user can hardly make a proper choice. Sometimes a man will buy a given boiler because his brother, who is 20 miles away, finds it a good variety, whereas the water in the two districts may be altogether of a different order.

Speaking generally, there are not many waters but what can be dealt with by chemists and improved. A water overladen with carbonate of lime can be rendered practically non-scale forming by the use of caustic lime. A water, with lime sulphate, can be cleared by means of soda; but sulphate of soda remains in solution, and though very soluble, must not be allowed to concentrate unduly. Some waters are nearly hopeless to treat. Take, for instance, the water yielded by the Thornhill Rock, one of the rocks on the Yorkshire carboniferous series. This water, when treated for scale prevention, will contain, after treatment, a larger amount of impurities per gallon than before treatment, but the salts are now more soluble. The water will not scale, but it will very soon concentrate to a dangerous degree. The concentration of salts is a danger that is far too little guarded against, and it is specially trying in locomotives.

Much more might be done in water treatment than is done. Railways especially might pay more attention to the subject. We have seen a good water condemned as full of scale forming matter, and as causing priming, when as a fact it was removing scale from the boiler, and doing this with boilers which had previously worked with hard water. By suitable timing of the stay of a locomotive at any one shed, its boiler can be periodically cleared of scale by simple transference to another shed.

There is, as stated by our contemporary, such a thing as fashion in steam boilers. At one time every electrical installation was fitted with locomotive type boilers. This boiler became fashionable, but it was simply used at first because all the early electric stations were temporary affairs at exhibition buildings, and the locomotive type boiler seemed the best under temporary conditions, but this boiler still goes into electric stations often with no regard to the conditions of water supply, though with good water it is without doubt one of the best and most economical.

The next fashion was the water-tube boiler, as to which one engineer, who really knew better, when gazing into a plate-glass shop front upon one such, exclaimed: "Them's the jockeys for me," or to that effect, as though the water-tube boiler was capable of universal application instead of being merely a boiler for its suitable environment. Unfortunately, however, the water-tube boiler has been made the victim of very numerous impossible laudations. Over 13 lbs. of

evaporation has been conferred upon it at least once. The power of reducing the gases below the temperature of steam in the boiler is yet another. Perfect circulation is allowed it without proof, and also absolute safety, though its tubes may split—and have done so, to the serious injury of attendants. Shell boilers have their thick-and-thin advocates, also, though it is often very difficult to instal them in an existing building, especially where an architect has had a word in placing the boiler space. We don't see that the steam user is very much between Scylla and Charybdis, as put by the *Engineer*, in having to choose between a hard scaling water and a soft water which will corrode. A soft water will not necessarily corrode a boiler. If it do so it must be acid, or perhaps charged with carbonic acid gas. If acid it should be run through a filter of limestone chips, and if charged with carbonic acid gas a little caustic lime should absorb this (or a little caustic soda), and the lime carbonate will form a protecting scale, which if it get too thick can be loosened off by letting the soft water act upon it untreated.

Our contemporary prefers the Scotch marine type boiler to all others, and there is much to be said in favour of it. It has most of the advantages of the Lancashire boiler, but magnified in that it has larger furnaces, and thereby should secure better combustion. It has large water contents, and is accessible all over for cleaning. It has the advantage, if desired, of no external seatings, but it is becoming quite usual to give it an outside exposure to heat by means of external casings. It has also the advantage of height, and thus more than competes with the water-tube boiler in respect of floor space, in which the Lancashire boiler is supposed to be extravagant.

The disadvantage of the Scotch boiler is its expense when under higher pressure; but in this respect, if a 6-foot boiler is safe with $\frac{1}{2}$-inch plates, a 12-foot boiler will be safe with 1-inch thick, and will be four times as big as the smaller boiler. Per unit of cross section, therefore, the larger boiler need only be of half the weight in its barrel. Thus a Scotch boiler shell, 10 feet long by 12 feet diameter by 1 inch thick, weighs as much, approximately, as a Lancashire boiler measuring 20 feet × 6 feet × $\frac{1}{2}$ inch, and is suited for equal pressure, while it has double the internal capacity, a fault, no doubt, in the eyes of those who do not believe in water capacity, or accumulators, or fly-wheels, or any other form of stored energy, though they are willing enough to use coal as a source of motive power, instead of relying upon a Solar motor, as it appears we, or our near descendants, will require to do, when all coal is used up—a period set by a writer in the *Engineering Magazine* at from four hundred to fifteen hundred years as regards Europe and America; Asia, Africa, and Australia, being left out of account.

For ourselves, we look to the increase of surface condensing, and possibly the extended use of flake graphite for cylinder lubrication as a powerful aid in preventing scale in boilers. The weight of water evaporated in a boiler is, roughly, tenfold the weight of fuel burned, and the accumulation of mud and scale cannot but be larger. With surface condensation a little hard water can always be added if required, and where oil is employed in the cylinders we should be inclined to avoid filters and use a centrifugal cream separator to get rid of this.

THE POSTMASTER-GENERAL'S REPORT.

It is doubtless the duty of those who have charge of the public finances of the nation to exercise discretion in the way of reforms or concessions; it is seldom, however, that the latter are boldly made, but when they are, universal satisfaction is expressed and the concessions are seldom a financial failure. It is somewhat surprising therefore that more is not done than is actually the case. The Jubilee reforms in the Post Office can hardly be regarded as other than unqualified successes, the public certainly consider them so, and even if the financial results had been less satisfactory than they actually are, it is certain that the ratepayers would not have called indignation meetings in every direction to protest against the waste of public money, as it would almost appear that the authorities imagine would be the case. The Postmaster-General, in his report, states that the increases in postal and telegraph revenues during the past year, notwithstanding the numerous reforms, amount to £273,441 and £104,369 respectively. The expenditure, it is true, was £712,808 over that of the previous year, but setting expenditure against revenue, the accounts still show the very respectable profit of £3,421,125 on the year, if nothing be allowed for interest on the capital created for the purchase of the telegraphs. This interest has, of course, to be met out of ordinary taxation, but the public do not, we imagine, grumble greatly at this.

The result of the diminished rate for the letter post has resulted in the growth of the latter being double what it was in the previous year, namely, 6·3 per cent. against 3·2 per cent. in 1896-97. The parcel post shows a like gratifying increase.

In the telegraph service the extension of the free delivery of telegrams to three miles has so far proved satisfactory, that although the total cost of the concession up to the end of the financial year amounted to £52,000, yet the gross revenue derived from additional telegrams is estimated to be £26,000, this being assumed to be the result of the advantage derived from the concession.

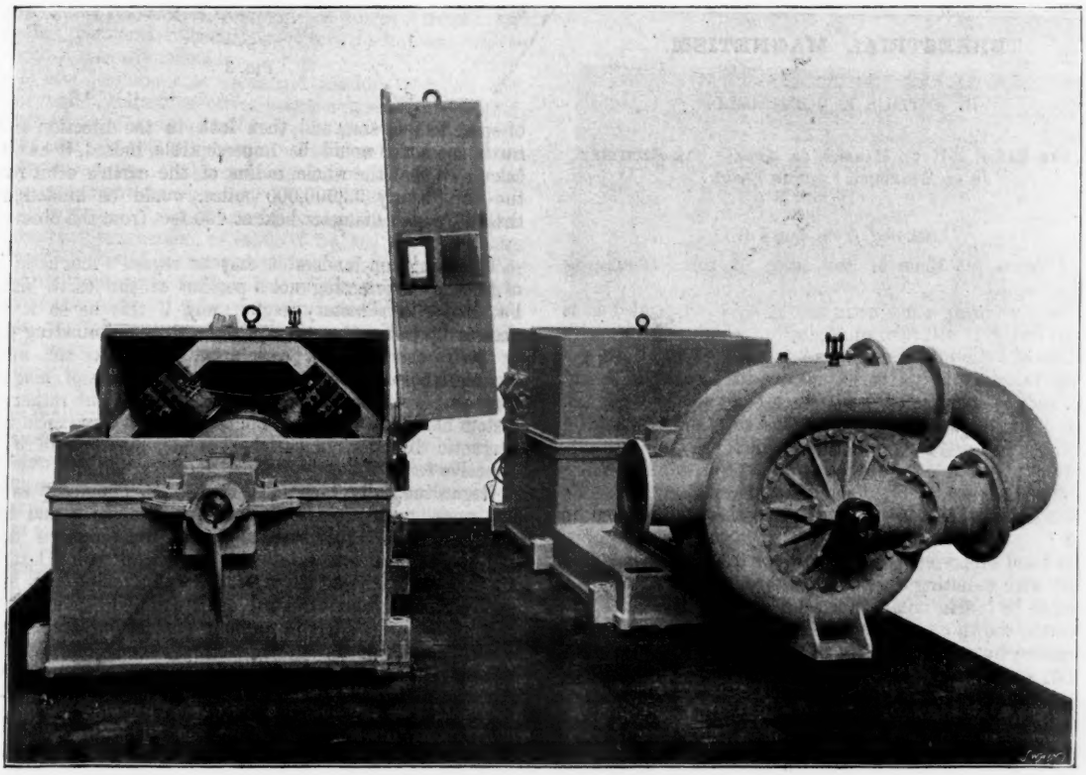
The reduction in the guarantee required for new telegraph offices has led to an increase of 49 new offices opened as compared with those opened in 1896-97. The reductions made in private wire rates has also resulted in a substantial increase in the demand for such means of communication.

The erection of the new buildings opposite the original St. Martin's-le-Grand Post Office is a matter of recent date, yet, large as these buildings are, they are insufficient to meet the rapidly increasing volume of business to be dealt with, and the Department has consequently decided to expend £200,000 on a scheme which makes provision for dealing more efficiently with the increasing work, both postal and telegraphic, in the metropolis, and under which better accommodation will be provided for the staff. Three new buildings will be erected at once. The old building of St. Martin's-le-Grand will be demolished with the exception of the outside walls, and within a new structure will be erected suited to modern requirements. While the work is in progress a portion of the business will be transferred to the Mount Pleasant offices in Clerkenwell, to which a new wing is being added. These parts of the scheme will cost £150,000. The Department has purchased the business premises of Messrs. Barnard & Sons, manufacturing silversmiths, Angel Street and King Edward Street, which will at once be demolished, and a new building erected on the site, which will provide ample dining and cloak room accommodation for the staff of 3,000 telegraph clerks at St. Martin's-le-Grand. The sum of £50,000 will be spent on this undertaking. As soon as a suitable site can be obtained, it is proposed to build a new post and telegraph office in the East Strand, where business has developed so rapidly in recent years.

The line to be taken by the Department in view of the report of the Parliamentary Committee on the telephone question does not yet appear to be definitely decided, but if a bold policy of active competition is decided upon, the volume of work to be done will be largely increased, especially in the engineering branch of the service.

LARGE ELECTRICAL PUMPING PLANT.

We illustrate below two large plants which have just been completed by the Phœnix Dynamo Manufacturing Company. It is believed that they are amongst the largest electrically-driven centrifugal pumping plants which have yet been made, and the same remark applies to the "enclosed" motors. The motors are each capable of maintaining a load of 100 B.H.P. on a circuit of 300 volts at a speed of 690 revolutions per minute. The armatures are 21 inches diameter, and have 254 conductors, wave wound, and connected to 127



bars in the commutators, so requiring two sets of brushes only. The brushes are of carbon, and are mounted in holders of aluminium. The machines are compound wound, the resistances being: armature, 0·008 ohms; shunt, 115 ohms, and series, 0·0035 ohms. The electrical efficiency of each machine is 98 per cent.

The pumps are twin series, and are capable of raising 72,000 gallons per hour a height of 126 feet.

TRAMWAY SPEEDS.

Inquiries have been made by M. H. Geron, of the Cologne Tramways, into the speeds found most suitable on various tramways. He has received replies from 21 companies, of which eight operate by steam, five by electricity, five by horses, one by compressed air, and two by combinations of some of the above methods. The replies came from Belgium, France, Germany, Italy, and Austria. M. Geron places the information he has received in the form of a paper to the Permanent International Tramways Union. He divides lines into the two classes of suburban and urban, the former being usually worked by steam, the latter by horses or electricity. Speed is naturally greater on the first class; but must always be dependent on other conditions—such as an independent right of way—which leaves speed simply dependent on technical and economic conditions alone. While speed is costly it is also popular, and leads to patronage and increased receipts. With ordinary tramways speed is regulated by other than economic or technical considerations, such as traffic conditions and local circumstances. Then the motive power is a large factor in determining speed. Horse traction naturally soon finds its limit of speed in the limitations of the animal. The speed is thus absolutely limited, apart from the possibility of higher speeds under the local conditions.

On the Italian tramways the maximum speeds are 16, 18, and 20 kilometres per hour (9·9, 11·2, and 12·4 miles per hour), and these are reduced to 6, 8, 10, or 12 kilometres in densely crowded streets and difficult passages, but the company think that the official maxima might very well be raised to 24 kilometres in ordinary street running, and to 30 kilometres (18·6 miles) on independent permanent way, and these speeds were even proposed by the authorities in a measure which, however, did not become law. This projected law laid down 24 kilometres as a maximum at any point, and there were special rules for falling gradients, curves, crossings, and other dangerous points, and also at night time. For railways constructed on ordinary roads the speed is limited to 30 kilometres, with similar restrictions as to grades, &c., prescribed for tramways.

The Belgian National Company of local railways limits its speed in populous districts to 7 and 10 kilometres, and at other parts to 14 and 17 kilometres. Without special authorisation the speed of trains outside crowded districts must not exceed 30 kilometres to be reduced to 10 when passing through villages and towns, and speed must be slackened when the approach of a train might frighten horses and other animals, and possibly lead to accident.

The management of the steam tramways of Bologne have failed in their application for power to increase speeds up to 22 kilometres from the present 18 kilometres limit. Other Italian lines are limited—at Milan to 18 to 20, Turin Province 20, and the steam tramways at Rome, Milan, and Bologna to 20 kilometres. All join in the opinion that speeds might be increased without additional danger and with additional profit.

At Crefeld, the German tramways are limited to 12 kilometres in populous centres, and 20 outside, and the so-called commercial speed only reaches 12 or 13, with this 20 maxi-

mum. Several accidents early in the life of the line caused the reduction from the original speed of 15 to as low as even 10 kilometres, beyond which it only recovered to the above 12 and 20.

The author thinks that the Belgian National Company's rules best conform to practical necessities, and the propositions submitted to the Italian Legislature closely resemble them. The Belgian local railway system now includes 1,500 k. (930 miles) of lines, and will soon be doubled.

We are indebted for the information which we have abstracted above to the translation of M. Geron's paper in the *Railway World*.

TERRESTRIAL MAGNETISM.

By ARTHUR E. COTTERELL.

"Is the Earth a Huge Magnet, or Merely the Recipient of an Ethereal Line of Force?"

(*Concluded from page* 371.)

Fig. 2 represents some of the lines of force emanating from a magnet.

If now we bring a magnetic needle, S′, N′, suspended so as to turn freely, it will take up a position which coincides with the lines of force into which it is brought; a second one will do the same, subject to variations due to position in line of force, and to attraction of the first needle N′ S′. Or again, if we place a piece of iron or other substance capable of receiving magnetism near the magnet, it will acquire magnetic properties, the direction of the polarity being determined by the lines of force and direction of their sign.

Does not this lead us up to the hypothesis illustrated in fig. 3?

Let N and S represent the two poles of a tremendous magnetic system with radiating lines of force through space which are shown to be few in number for sake of simplicity. Let E be the earth, shown on exaggerated scale, moving in space, and intersected by a magnetic line of force, S′ N′. The polarities, N and S, are only illustrative of magnetic sequence in a general sense. For convenience we use the term N and S, taking our earth geographically.

From what has preceded we can readily understand that the earth may become magnetic from the fact of its lying in some huge magnetic lines of force. It might be objected that the earth as a whole is not entirely or equally distributed with substances capable of magnetism, but this argument can be met in several ways. Firstly, all substances may be more or less capable of magnetisation, though not of exhibiting it when in comparatively minute fragments, or in the second place, owing to the quantity of iron in the earth's formation, generally the magnetism is exhibited in the earth as a whole.

It might be suggested that the daily rotation of the earth, or its axis, would cause this hypothetical line of force to shift considerably around the poles during each day, to say nothing of greater variations during the year.

Well, we know that there are daily and yearly movements, but these only tend to confirm the theory suggested. At

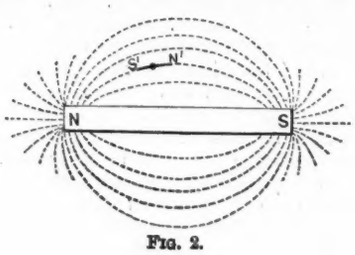


Fig. 2.

first thought the suggestion that the magnetic axis would shift round the geographical poles, appears to be a very serious objection indeed, but happily it is capable of being dispelled, and in this way:—It has been suggested that the theatres of the great magnetic force are situated at enormous distances in space. Let us now remember that the nearest known star, Alpha Centauri, is calculated to be situated at no less than 20,000,000,000,000 miles from this globe of ours. If we could transplant ourselves through the realms

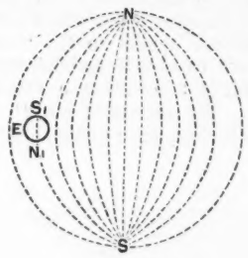


Fig. 3.

of space to that star and then look in the direction of the earth, the latter would be imperceptible, indeed, it has been calculated that the whole radius of the earth's orbit round the sun, nearly 93,000,000 miles, would be hidden by a thread $\frac{1}{25}$ inch diameter held at 650 feet from the observer's eye.

This reflection renders it easy to regard a magnetic line of force as intersecting not a portion of the earth merely but rather a planetary region, and if this be so it must necessarily follow that there will be some culminating point or path which in our case approximates to the known magnetic poles. We must not regard the lines of magnetic force as a series of infinitesimally fine lines, but rather as a system of diffused lines, which they really are, creating a magnetic direction in their aggregate, rather than by the directive force of any individual line.

Regarding daily variations, Prof. S. P. Thompson says in his work, "Elementary Lessons in Electricity and Magnetism," page 120, "About 7 a.m. the compass needle begins to travel westward, with a motion which lasts till about 1 p.m.; during the afternoon and evening the needle slowly travels back eastward until about 10 p.m." After this it rests quiet; but in summer time the needle begins to move again slightly to the west at about midnight and returns again eastward before 7 a.m. He goes on to say that these delicate variations "are never more than 10′ of arc," and "appear to be connected with the position of the sun; and the moon also exercises a minute influence."

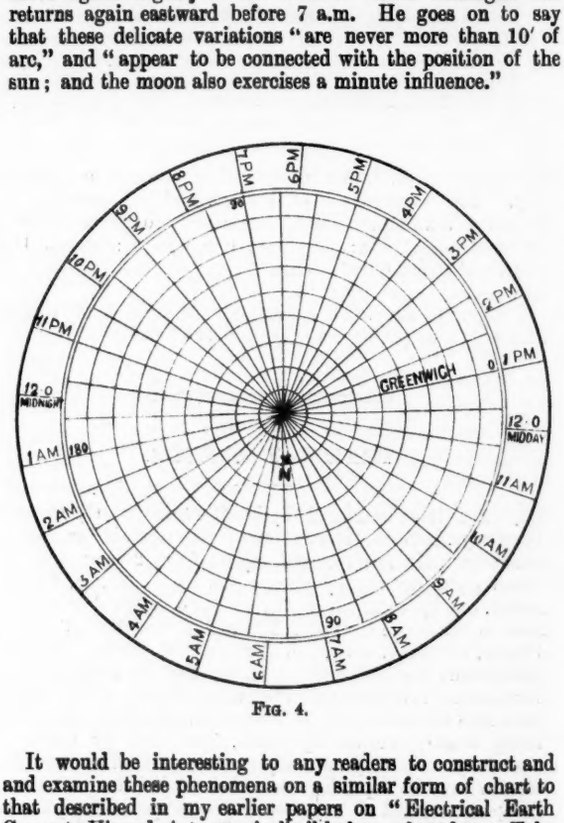


Fig. 4.

It would be interesting to any readers to construct and and examine these phenomena on a similar form of chart to that described in my earlier papers on "Electrical Earth Currents Viewed Astronomically" before referred to. Take

a piece of paper or cardboard of any convenient size, and sketch out the longitudinal and latitudinal lines of the Northern Hemisphere, mark thereon the positions of the North Pole and of Greenwich, and around this hemisphere mark out the 24 hours which represent day and night.

If the hemisphere is now cut out so as to leave the dial of 24 hours, and the former is pinned axially to a board so as to enable it to be rotated within the area of the dial, it is easy to compare the relative position of the north magnetic pole at various hours of the day, and this experiment is full of instruction and coincidence with the effects laid down by Prof. Thompson.

Fig. 4 illustrates the north magnetic pole as having approximately reached its westward position at 1 o'clock, and the other positions indicated by Prof. Thompson will be found to practically coincide.

It is now desirable that we should remind ourselves that the magnetic declination varies between summer and winter, viz., 12′ in the former and 7′ in the latter. In this connection we shall do well to remember that the distance between the two extremities of the earth's orbit of revolution round the sun is computed to be about 186,000,000 miles.

With regard to the question of the variation of the direction of the earth's magnetism, as induced by the suggested line of force, it should be remembered that there are two other important movements, independent of the rotation and revolution of the earth. I refer to the precession of the earth's axis—a conical movement, which completes a revolution in 25,867 years, or thereabouts—and to the nutation due to the moon, another conical movement of about $18\frac{2}{3}$ years' duration. Then, again, we must consider that there are certain motions belonging to the stellar or sidereal system which cover countless ages. Our sun himself is believed to be dashing through space in the direction of the constellation, Hercules, at the terrific rate of 150,000,000 miles per annum, carrying in his wake the train of planets and satellites which revolve around him in corkscrew fashion.

Each and all of these command consideration, and the author has no doubt that in the mean of their total effects will be found the true cause of the variation to which terrestial magnetism is heir.

Amongst other questions which arise we notice the following:—Where are the centres of magnetic force? What are the limitations of space, or rather, perhaps, space as occupied by celestial bodies, and what is magnetism? This question is, however, as difficult as another, viz.: What is electricity? to which no satisfactory answer can yet be given. We know how to handle electricity and magnetism, and to gauge their powers, but we cannot describe their nature. This lack of knowledge, however, does not hamper our practical applications, nor does it hinder the study of magnetism, or rather its effects. A careful survey of magnetic declination, inclination and force, should reveal the first, and afford some suggestions of the second.

ELECTRIC MOTORS IN A TANNERY.

A new application of electricity as a motive power has recently been adopted in the tannery of Messrs. Dunn Bros., Cork, Ireland. Of late years, in the early stages of the tanning process, steam-power has been largely used to agitate the leather suspended in tanning liquor, the object being to promote the tanning. Various mechanical appliances have been adopted. The American rocker system, so largely used in the United States, has been for years in operation at Messrs. Dunn's tannery, the necessary motion being given by eccentrics on a shaft driven by a steam engine. Each rocker consists of a strong wooden frame at the top of a tanpit, supported on pivots, and free to move about 6 inches in a see-saw fashion. From this frame the leather to be tanned is suspended in the tanpit, which is filled with tanning liquor. When the frame rocks the leather is gently agitated in the liquor. Experience proves that the best results are obtained with an intermittent motion.

With the usual arrangement, it is necessary that the starting and stopping should be done by someone on duty for that purpose, and consequently the intermittent motion cannot be continued during the night without considerable extra expense. In the new arrangement, electricity developed by a dynamo driven by a steam engine, is stored in accumulators. A clock turns a commutator, which at intervals switches on a weak current. This current works a relay, which switches on the full power of the accumulators to a motor, which rotates the shaft moving the rockers. The commutator being connected with the minute hand of the clock turns on the electricity for some minutes every hour during the day and night. In this manner alternate motion and rest, found to be so desirable, is automatically produced during the night as well as in the day. In this tannery there are 20 of these rockers, each capable of carrying 50 butts or hides.

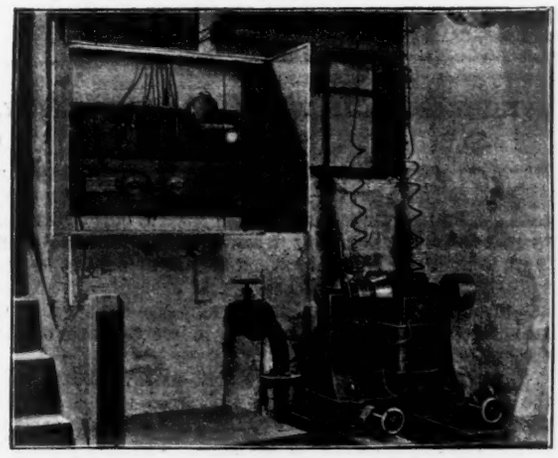


Fig. 1.

The great economy of power obtained by the use of electro-motors is very well exemplified in this instance. The whole set of 20 rockers contain at the time of test about 800 hides or butts worked with 26 volts at the accumulators and a current varying from 14 to 18 amperes, or an average of 410 watts, or less than half a unit per hour.

The motor and gearing have been made by Mr. G. Percival, electrical engineer, of Cork, with a special regard to economy in working, and possibility of increasing the power if required, by simply adding to the number of cells in the accumulator. Attempts of various kinds have

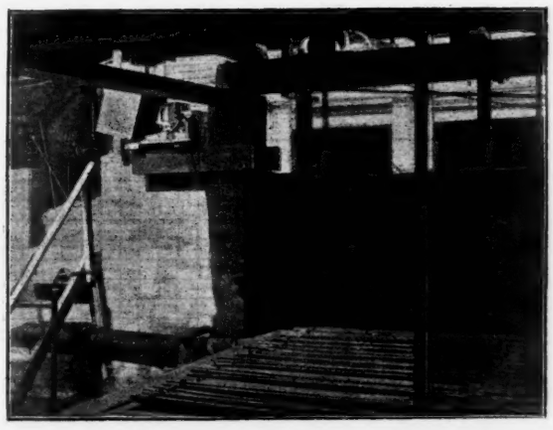


Fig. 2.

been made to accelerate the tanning of leather by electrical means; some of these systems, which have been electro-chemical modifications of the tanning process, have been reported in the Electrical Review from time to time. Messrs. Dunn Bros.' improvement leaves the tanning process unaltered, though expedited. The users

of the leather therefore will find it exactly the same as formerly in quality, texture, and appearance. It has been an objection to some of the new processes that the resulting product has differed in some of these particulars from the leather to which customers are accustomed, and on which they have found that they can rely.

The machinery in this tannery is of the most modern type. The electrical system of working the rockers now described is the subject of a patent.

The photographs show the working portions of the apparatus. Fig. 1 is a view of the dynamo, clock, and automatic switch in engine room. Fig. 2 shows the motor and portions of the rockers (about one-tenth part) over the tanpits. The small bell near the motor is rung by the action of the F.M. of motor at the instant of closing shunt circuit, and before the motor moves, warning men to stand clear of rockers, &c.

SYNCHRONISM IN WIRELESS TELEGRAPHY.

Dr. Martin Tietz, of Charlottenburg, has been making a series of interesting experiments to determine under what conditions a receiver can be tuned to respond only to a given frequency.* As Dr. Tietz remarks, it has hitherto been impossible, in the Marconi system, to tune a receiver to the transmitter, and his experiments appear to supply the explanation of this phenomenon, and thereby give further insight into the operations that take place in the working of the wireless telegraph.

Starting from the fact that effects at great distances with the Marconi system can only be obtained with a coherer combined with a long conductor, Dr. Tietz sought to explain this by exact quantitative experiments. For nearly all his measurements he used as a receiver a thermo-element (after *Klemencie*), or a dynamobolometer (after *Rubens*), the intensity being measured by the swing of a galvanometer, a method which gives much more accurate results than the coherer. As a source of radiation, the Marconi-Righi emitter, excited by a 20 cm. spark coil, was used. A wire 80 cm. in length was connected to each of the outer balls of the emitter, and two wires of the same length were connected to the thermo-element.

Experiments were first tried by varying the distance between the transmitter and the receiver, and ascertaining the effect by means of the deflection of the galvanometer. The curve obtained was found to lie between the curve due to radiation from a point, and that due to radiation from a wire of infinite length; showing that the electric waves followed the same law as radiation of light, and that the radiation proceeded from every point of the wires.

Another series of experiments were made to investigate the phenomena of resonance. A transmitter with wires of constant length was used; and a receiver (a thermo-element) with wires whose length, L, was varied. When a curve was

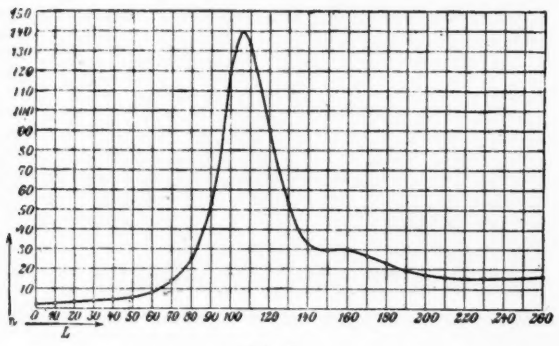


Fig. 1.

drawn, showing the relation between the length, L, and the deflection, *n*, of the galvanometer, a very distinct and short maximum was shown when the length, L, was the same as the length of the wires on the transmitter. This curve is shown in fig. 1. By using a relay of the proper sensitiveness, a receiver may be made to respond only when it is in tune with the transmitter.

It now became a matter of interest to determine whether any maximum existed when Marconi's arrangement of earthing one of the poles was made use of. Experiment showed, in this case, only a weak intensity, and the curve drawn gave no indication of the existence of resonance; the galvanometer deflection remaining the same for all lengths of the wires on the receiver.

When the coherer was used as a receiver, the results were quite different from those obtained with the thermo-element and the dynamobolometer. In the thermo-element and the bolometer, heat is produced by the electric oscillations, which in the former creates a thermo-electric force, and in the latter a change of resistance. Quite different is the behaviour of the coherer and the spark micrometer, which, in their action show the greatest similarity to one another. Prof. Slaby* considers that the coherer is merely a very fine spark micrometer. In the spark micrometer the waves must first generate sufficient E.M.F. to send the spark across the air-gap before any effect is observed. It is a matter of indifference how often this happens per unit of time. Different types of transmitters must therefore be used to obtain the best effects with the different types of wave indicators.

Dr. Tietz used the spark micrometer in his experiments as being better under control than the coherer. The intensity was measured by the length of the spark in the receiver with different lengths of wires. This intensity was found to increase as the lengths of the wires were increased, but there was no maximum point.

From these experiments it was concluded that resonance in the Marconi system was impossible so long as a coherer was used in the receiver. On the other hand, the resonance effect was shown to be very well marked with the thermo-element and the bolometer. The question now to be answered was whether these latter instruments were equally sensitive with the coherer. With the instruments used in the experiments, the coherer showed itself decidedly superior in sensitiveness, but Tietz proceeds to show several ways in which the resonant receivers can be improved in sensitiveness.

The sensitiveness of the bolometer was improved by using stronger currents in the bridge. When the best strength of current was used, the deflection of the galvanometer of the bolometer was 65, as compared with a deflection of 25 in the thermo-element. The thermo-element can be rendered much more sensitive by combining several elements into a battery, and by increasing the section of one set of junctions. The deflection in this way was raised from 25 to 40.

Dr. Tietz showed also that the intensity of the radiation could be greatly increased by modifying the Marconi-Righi transmitter. For instance, if a number of spark gaps in series were used. Wires connected to each insulated conductor between which sparks passed, instead of the single pair, also increased the effect. A condenser inserted in paralled with a spark gap likewise greatly enhanced the efficiency of the radiator.

The best radiator was made by sticking pieces of bent wire in a cake of paraffin, sufficiently close together for a spark to pass. The whole was then placed in a vulcanite box filled with oil. A certain number of sparks per minute, depending on the capacity, the coil, &c., was found to give the best results. Dr. Tietz considers that still stronger radiation may be obtained by using more powerful sources of energy, such as may be obtained with transformers and alternating currents with condensers in circuit.

Dr. Tietz was able with his apparatus to transmit signals successfully over a distance of 200 m. His apparatus, however, could not be adapted to work a Morse instrument with the ordinary telegraphic relay. To get over this difficulty he has devised what he calls the "light relay." In this instrument the reflecting galvanometer, when deflected, throws its beam of light on a selenium cell, the current through which works the Morse instrument. Zickler's method of using ultra-violet to cause a spark discharge he proposes also to make use of.

Dr. Tietz's experiments are interesting, as throwing light on the *modus operandi* of the wireless telegraph, and may

* *Electrotechnische Zeit.*, xix., p. 562.

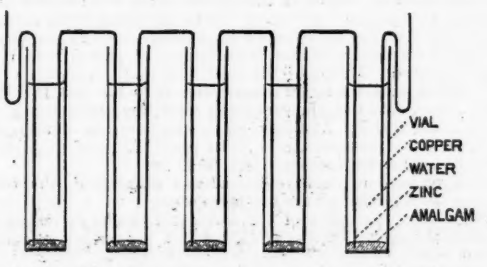
* A. Slaby. "Funkentelegraphie," p. 14.

point the way to practical improvements of real value. Some of his own devices, however, appear to us to be better fitted for the laboratory than the field.

A NEW WATER BATTERY.

A simple form of water battery, devised by Mr. A. C. Longden, has recently been described in the New York *Electrical World*. In this battery the important new feature is the zinc plate, which consists of a thin film of zinc amalgam, spread over a copper plate which is used as a support. The plates are made in pairs by bending copper strips so that the two ends of a strip will dip into two adjacent vials. Then one end of each strip is amalgamated with mercury containing a little zinc. The plate should be amalgamated to within about a centimetre of the top, and the top of each pair of plates should be coated with paraffin or shellac, preferably shellac, to prevent mercury or salts from climbing. The zinc plate is about a centimetre longer than the copper, and stands in a globule of zinc amalgam in the bottom of the cell. This globule of amalgam acts as a feeder to keep the surface of the plate continually bright and fresh.

The details of construction are shown in vertical section in the accompanying figure.



The vials used are preferably of the tube form, with straight sides, though the ordinary homœopathic vial with contracted neck will answer. Of course, for a given size the straight form will accommodate larger plates. This is a matter of importance if the battery is to be used on a closed circuit. For electrometer or condenser work the vials may be the smallest size obtainable and the plates may be made of copper wire.

The following data will enable the reader to judge what size the cell should be for any required work :—

Size of vial.	Depth of water.	Width of plates.	Approximate resistance.
·7 × 3·5 cm.	2· cm.	No. 14 wire.	2,000 ohms.
1· × 5· „	3·5 „	7 mm.	250 „
1·4 × 6· „	4·5 „	12 „	100 „
1·7 × 7· „	5·5 „	15 „	60 „

Of course the resistance may be varied by varying the strength of the solution. The above results are for a 1 per cent. acid solution. A stronger solution may be used without bad results, if the tops of the vials are coated with shellac to keep the salts from climbing. If the battery is to be used only on open circuit the strength of the solution may just as well be reduced to $\frac{1}{100}$th of 1 per cent. and then there will be no trouble about climbing salts.

As the water evaporates from the cells it should be replaced with pure water, not with the acid solution originally used, otherwise, the concentration of the solution will increase. It is not a very difficult matter to seal the cells and thus prevent evaporation entirely.

The E.M.F. of these cells is a little more than a volt. Usually about 1·08 if the cells are carefully set up.

In amalgamating the plates it is important to avoid getting any mercury on the end which is to be used as copper. Otherwise, the E.M.F. will be greatly reduced. It may be well to remark that although the end of the plate which is to be used as zinc must be perfectly clean before it is amalgamated, an ordinary layer of oxide on the copper end will do no harm whatever, and it will greatly reduce the probability of accidental amalgamation.

Of course, such cells as these will polarise rapidly if they are over-worked, but they also recuperate quite rapidly.

The chief value of this cell lies in the fact that in weak solutions the zinc arrangement is practically permanent. The E.M.F. never falls below its normal value unless polarisation is allowed.

REVIEWS.

The Electrical Engineers' Central Station Directory. London : Biggs & Son.

Central station engineers cannot yet complain of the lack of attention that is paid to the statistical side of their undertakings. Moreover, it is to be said to their credit that they have not yet tired of giving information.

There are published annually three distinct sets of statistics devoted to central stations, each of which is no doubt thought better than the others, but the publication under review is certainly the only directory which gives itself up entirely to recording the details of central stations and allied undertakings. Not only are the chief engineering features given minutely, but the financial returns of many works are set forth. There are also Board of Trade regulations under the Electric Lighting Act, a list of electric tramways, biographical notices of prominent central station men, and a useful list of advertisers. The information is very full, and the publication ought to prove of considerable use.

The Mechanics of Machinery. By A. B. W. Kennedy. Third Edition. London : Macmillan & Co., 1898.

This is essentially a book for students, and, perhaps, for some draughtsmen, and it was the author's intention to provide for the practical man as well as the student, for which purpose he has adhered, with much apology, to the use of the pound, and spent a good deal of space in showing how wrong it is of him to do so, yet that its retention is necessary. He seems to have done this in fear and trembling, as in the midst of a very Bashan of terminology bull pedants. We are, after all, very much inclined to doubt the value of such books as this, save as drilling for the student. The author has confined himself entirely to the mechanics of constrained motion, and, except in two cases, the Tower engine and the Hooke joint, to motions in one plane.

With a thorough mastery of all that this book can teach to a man as a student, he should be well equipped for any problems that may come to him in practical work. At the same time the mental training in mechanics can never replace that particular gift possessed by some men in devising mechanisms for effecting given objects with a minimum of parts. Actual machine design is rather a question of reducing to the smallest number of parts, and we once heard the chief draughtsman of a railway, state that he did not think much of a certain designer, for the man had used seven pieces where he himself had found two to be sufficient. Possibly a good grounding in the mechanics of machinery would have prevented this, or it might have at least improved the design.

In actual practice the number of mechanisms to be dealt with by any one man is comparatively few. The idea that in practice the young student will encounter tremendous problems is a very mistaken one. Few machines are really complex. The headstock of a self-acting mule is, to look at casually, about the worst bit of machinery to be found, yet if taken in detail it resolves itself into a series of very simple devices united by trains of wheels to give definite timing, and very much the same may be said of other machinery. Thus in the Jacquard loom, producing elaborately figured fabrics, there is a great simplicity about the mechanism.

No doubt this book will be valuable to the student, but we venture to say it would be more so if to every mechanism explained, there could be given an example from practice showing how and why the motion has been employed, and

where it has been perhaps modified to suit a certain end. The skew bevel wheel, for instance, is working by millions in this country, yet comparatively few know of them. Screw wheels again have come into use considerably with the gas engine. No reference to their use is to be found here.

Perhaps the best chapters are those on parallel motions and on the dynamics of mechanism, this latter seeming, however, somewhat outside the scope of the book. Indeed, it scarcely seems to us that there need have been any consideration of forces, and weight and mass, in a book professedly dealing only with constrained motions. We should state that this is the third edition of the book, and a few errors have been corrected and emendations made in the text and figures from the original edition. We should like to see a book from the pen of Prof. Kennedy dealing with mechanism, but of a more practical kind, and combining with actual examples a plain and practical treatment.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, BRISTOL, 1898.

NOTES ON THE ELECTRIC LIGHTING SYSTEM AT BRISTOL, WITH SPECIAL REFERENCE TO AUXILIARY PLANT.

By H. Faraday Proctor, City Electrical Engineer, Bristol.

Read before Section G. September 12th.

In the following paper it is proposed to give a mere outline of the electric lighting undertaking at Bristol, and the results of the working of some of the auxiliary plant.

The electric lighting works at Bristol are the property of the Bristol Corporation. Alternating current is supplied to private customers, and continuous current is used for the public street lighting.

At the present time the whole area equipped is supplied from one generating station, which has a water frontage to the Floating Harbour, and is situated at Temple Back, well within the area of supply.

The engine room and boiler house both extend the length of the building, and adjoin one another. The coal bunkers occupy a wedge-shaped piece of land between the boiler house and the Floating Harbour.

There are 12 Lancashire boilers; three of these are 24 feet × 8 feet diameter, and the other nine are 28 feet × 8 feet diameter, all working at a pressure of 125 lbs. The boilers are all fitted with coking stokers, mechanical elevators, and conveyers, driven partly by steam engines and partly by electric motors. An economiser has been laid down recently. Two chimneys are placed between the third and fourth boiler and adjoining the twelfth boiler respectively. Welsh pea-sized coal is used, and is delivered from the barges which come alongside, over a weighbridge, direct into the coal bunkers. From each boiler a single 5-inch steam pipe leads through the engine room wall to the steam ring-mains.

The main engines are all of the Willans central valve type, and vary in size from 100 to 700 I.H.P., the aggregate horse-power being 3,700.

Alternators with revolving disc armatures are direct coupled to the engines, and run in parallel with one another.

Four dynamos, each giving 80 amperes at 600 volts, are used for arc lighting and for driving the station motors. Two dynamos, each giving 500 amperes at from 100 to 130 volts, and a small battery of accumulators, supply the exciting current for all the machines, and also energy for a portion of station lighting.

The main switchboards are of double-pole type, and will probably be soon replaced by single-pole boards, when the outer conductors of the cables will be earthed.

A new arc lighting switchboard has just been introduced, the arrangements providing for the coupling of any of the 18 new arc circuits on to any of the four dynamos. This switchboard is particularly compact, each circuit requiring only 3½ inches of the length of the board.

Eighteen high tension feeder cables run direct to transforming stations. The distribution of energy to customers is on the three-wire system by triple concentric cables, the low pressure system being divided into three distinct networks.

There are about 130 miles of cables, all of which are lead sheathed and steel armoured. These are laid direct in the ground, being loosely covered with common bricks as a guard against accidental injury by picks or other road tools.

The street arc lamps are arranged with 12 lamps in series on each circuit, all the circuits being run in parallel on one or more dynamos.

There are 38 sub-stations, which, with the exception of a few of those originally laid down, are all constructed under the footways, their dimensions being 12 feet by 6 feet by 6 feet 6 inches deep. They are built of brick with cement, the walls being 1 foot 6 inches to 2 feet thick; the ventilation is by means of two 6-inch pipes—inlet and outlet—connected to a small divided box with vertical gratings set against or let into the nearest external wall of adjoining premises. No trouble from gas or sweating has ever been experienced since the adoption of these arrangements.

Note.—Five of the 38 sub-stations are not yet working.

A considerable amount of machinery has been added during the past few months.

The following are the results of trials made with sundry of the auxiliary plant:—

In all cases the steam consumption has been ascertained by condensing the exhaust steam and weighing the water collected, and the results of the pump tests have been reduced to show the steam consumption per horse-power-hour of work done, such being calculated from the volume of water, and the pressure at which it was delivered.

For the purpose of facilitating comparison, the results of electrically driven plant are given in pounds of steam consumed, 32·0 lbs. of steam per kilowatt-hour, or 23·87 lbs. per E.H.P.-hour being allowed, that being the steam consumption of the smallest generating plant used in the station.

Feed Pumps.—Steam pump, capacity 4,000 gallons per hour, and electrically driven pump of the same capacity. The steam pump is compound duplex, direct-thrust, non-condensing. It has been in use about five years, and is in good repair.

The motor pump is a three-throw feed pump, driven by a 600-volt continuous current motor, running at 650 revolutions per minute, with speed reduction by cotton ropes and a pair of spur wheels, the ratio of reduction being 12·9 to 1.

The results are:—

At Full Load.

Steam pump 98 lbs. steam per B.H.P.
Electric pump 43·2 lbs. steam per B.H.P.

At ⅓th Full Load.

Steam pump 252· lbs. steam per B.H.P.
Electric pump 245·4 lbs. steam per B.H.P.

In this trial at ⅓th load the steam pump was run slowly to reduce the output, but the output of the electric pump was reduced by the opening of "bye-pass" or "relief" cocks, the pump being run at full speed. On reducing the speed of the electric motor 25 per cent. by lowering the armature voltage, the efficiency at partial load is very much improved. At about ¾ full load, with all three plungers of the pump doing work, the steam consumption is 35 lbs. per B.H.P. At about ½ load, with two plungers doing work, the steam consumption is 44 lbs. per B.H.P. At about ¼ load, with only one plunger doing work, the steam consumption is 74 lbs. per B.H.P., and when running light the total steam consumption is 66·25 lbs.

During these four trials the ¾ speed was maintained, the delivery being again regulated by the bye-pass cocks.

On lowering the speed of the motor still further by reducing the armature voltage to 100, the efficiency at a low output is again improved.

At ⅓th of full load, the pounds of steam per B.H.P. = 68·4, being only 27 per cent. of that consumed by the steam pump at correspondingly light load.

The conclusions arrived at are:—

1. The motor feed pump will work with from 27 per cent. of the steam consumption of the steam pump.

2. The output of a motor pump should be controlled by regulating the speed of the pump, the employment of bye-pass cocks, resulting in the loss of much energy.

3. With a motor-driven feed pump, where the motor runs at 580 revolutions per minute, and the pump at 45, an efficiency of 67 per cent. can be obtained.

Donkey Pumps.—Steam and motor-driven pumps. The steam pump is duplex, direct thrust, non-condensing; its capacity is 2,500 gallons per hour, pumping against a head of 41 feet. The pump has been in use about five years, and is not in good repair.

The electric pump is a 5-inch centrifugal pump, driven direct by a 600-volt motor, at 400 revolutions per minute. Its capacity is 25,000 gallons per hour, pumping against a head of 26 feet 6 inches.

The steam pump consumes 544 lbs. steam per B.H.P.-hour.
The electric " 95·5 " " "

It will be noticed that these pumps are not directly comparable, their capacities being very different, but the steam consumption is so very much less with the electric pump as to indicate somewhat the comparative efficiency of the two kinds of plant.

The efficiency of the 5-inch centrifugal motor pump with a head of 26 feet 6 inches is found to be 25 per cent.

Centrifugal Circulating Pump.—Steam pump, capacity 2,300 gallons per minute, and motor pump of the same capacity, both working against a head of 15 feet.

The steam pump is a 12-inch centrifugal pump, coupled direct to a vertical compound condensing engine, working at 210 revolutions per minute.

The motor pump is a 12-inch centrifugal pump, direct coupled to a 600-volt motor running at 400 revolutions per minute.

The result of the trials show that the—

Steam pump takes 90·6 lbs. steam per B.H.P., and its efficiency is ... ... 25 per cent.
The motor pump takes 48·26 lbs. steam per B.H.P., and its efficiency is ... ... 46 "

Mechanical Stokers Driving (by steam and by electricity).—An elevator, conveyer, and the stokers of seven boilers are driven by a vertical non-condensing engine through a belt and one pair of spur wheels, the speed reduction being in the ratio of 12½ to 1 of the stoker shaft.

An elevator, conveyer, and the stokers of five boilers, all of the same make as those above mentioned, are driven by a 600-volt motor,

through a belt and with worm gearing, the speed reduction being in the ratio of 38½ to 1.

The whole of this latter apparatus being quite new, it is probable that during the trial it worked rather more stiffly than the older steam-driven gear.

To work the elevator, conveyer, and the stokers of five boilers, the engine indicated 4 H.P., with a total steam consumption of * lbs. The motor absorbed 4·5 E.H.P., with a total steam consumption of 109 lbs.

Feed Water Filters.—A considerable amount of difficulty has been experienced in efficiently extracting the small quantity of oil found in the condensed water. A low pressure filter, in which coke and wood shavings were employed, was first used. A high pressure filter, packed with sawdust, is now employed, and also a centrifugal cream separator.

The centrifugal separator is found to extract the oil most perfectly, and when driven by an electric motor, the value of the power absorbed is very small, being about 1⅛d. per 1,000 gallons separated. The separator is one of the usual types employed for dairy purposes, and has a Laval steam turbine attached; its capacity is 400 gallons per hour.

When separating 400 gallons per hour, the steam consumption is:—

When driven by the steam turbine... 220 lbs. per hour.
„ „ motor ... ... 37·6 „ „

As the separator, when worked by the motor, was driven by means of a leather strap, and the steam turbine was not disconnected, it is probable that, with direct driving, the cost of separation can be reduced to below 1d. per 1,000 gallons.

The separation is so perfect, and the power required so small, that filtration by centrifugal action is thought worthy of careful attention and further development.

Tables, giving details of the foregoing trials, have been prepared, but their rehearsal would be tedious, and, therefore, no further particulars have been included in this paper than necessary to show the actual comparative results, and the general character of the station in which such results were obtained.

* This result could not be made, owing to this steam plant not being available for testing purposes; the new electric plant not being out of contractor's hands.

Steam Feed Pump.

Type.—Duplex, direct thrust, double-acting, non-condensing.

Pumping capacity.—4,000 gallons per hour.
Steam cylinders.—Compound tandem: 2 H.P., 5-inch diameter; 2 L.P., 8-inch diameter.
Pump plungers.—Four, 4¾-inch diameter.
Stroke.—8 inches.
Normal speed.—50 complete cycles per minute.

Per cent. of full load.	Speed per minute.	Gallons per hour pumped.	Pounds pressure at delivery.	I.H.P.	B.H.P.	Steam consumption per hour in pounds.			Efficiency. B.H.P. / I.H.P.
						Total.	Per B.H.P.	Per I.H.P.	
130	62	5,230	125	...	7·627	800	105	...	...
130	62	5,230	125	...	7·627	760	99·65	...	...
128	59	5,124	125	...	7·471	666	89·13	...	...
18	13·9	730	130	1·612	1·11	279	252·4	...	...
16	13·18	636	130	...	·96	243	251·9	...	...
				...					

Motor Feed Pump.

Type.—Three-throw driven by 600-volt continuous current motor with double reduction gear.

Capacity.—4,000 gallons per hour.
Plungers.—3 inches by 5½ inches diameter, 5-inch stroke.
Speed.—Motor 800 revolutions per minute.
„ —Pump 62 strokes per minute.
Gear.—3—2½-inch cotton ropes; driving pulley, 14 inches diameter, driven 3 feet 10 inches diameter; 2 spur wheels, driving 25 teeth, driven 112 teeth, 1¼ inches pitch.
Motor.—Bar armature, simple horse-shoe magnet type, separately excited at 100 volts.

The pump has bye-pass cocks connecting the deliveries with the common suction by which the amount of water to be pumped can be regulated, the pump speed being constant.

Per cent. load.	Speed.	Armature volts.	Galls. per hour.	Watts exciting.	Watts armature.	Total watts.	E.H.P.	B.H.P.	Lbs. of steam per hour.		Efficiency per cent.	Lbs. press. at delivery.
									Total.	Per B.H.P. hour.		
111	...	635	4,440	520	11,340	11,860	15·9	88	380	43·1	55·4	170
19	800	600	768	540	8,372	8,912	12	1·17	285	245	10	130
9	800	600	360	533	8,052	8,585	11·5	·55	275	503	5	130
0	800	600	...	520	3,105	3,625	4·9	...	116	...	...	...
Pressure supplied to armature reduced 25 per cent.												
80	576	445	3,200	535	5,437	5,972	8·0	5·41	191	35·3	68	145
57	579	445	2,271	535	4,495	5,030	7	3·71	162	43·7	55	140
27	584	445	1,088	535	3,271	3,806	5·1	1·65	122	73·7	32	130
0	588	447	...	535	1,605	2,140	2·9	...	66	...	...	...
Pressure supplied to armature reduced 83 per cent.												
14	111	100	556	535	1,200	1,735	2·32	·81	55·5	69·4	35	125

Steam Donkey Pump.

Type.—Duplex, direct thrust, non-condensing, double-acting.

Pumping capacity.—2,500 gallons per hour.
Cylinders.—2 H.P., 3 inches diameter.
Plungers.—4 H.P., 4 inches diameter.
Stroke.—6 inches.
Suction.—8 feet.
Delivery.—33 feet. Total head 41 feet.
Note.—A higher load than 74 per cent. cannot be obtained.

Per cent. of full load.	Speed per minute.	Gallons per hour pumped.	I.H.P.	B.H.P.	Steam consumption per hour.			Efficiency. B.H.P. / I.H.P.	Actual head feet.	Total head feet, allowing for pipe friction.
					Total.	Per B.H.P.	Per I.H.P.			
74	65	1,850	1·8	·39	240	613	134	21·8 %	41	41·79
67	55	1,668	1·5	·35	182	516	119	23·2 %	41	41·79
55	48	1,379	1·3	·29	147	505	111	20·0 %	41	41·79

5 Centrifugal Motor Pump.

Type.—5 centrifugal pump driven direct by a 600-volt continuous current motor, separately excited at 100 volts; speed, 650 revolutions per minute; suction, 7 feet 6 inches; delivery, 19 feet. Total lift, 26 feet 6 inches; suction, 5½ inches diameter; delivery, 5 inches diameter. Pipe friction at 21,000 gallons per hour 1·86 feet head, and is allowed for (28·36 feet head).

Gallons per hour delivered.	Watts exciting.	Watts armature.	Watts total.	E.H.P. absorbed.	B.H.P. output.	Lbs. of steam per hour.		Efficiency. B.H.P. / E.H.P.
						Total	Per B.H.P.	
25,222	658	9,375	10,033	13·45	3 33	321	96 4	24·8%
20,930	658	8,100	8,758	11·74	3 0	280	93 3	25 5%
20,450	658	8,100	8,758	11·74	2 93	280	95·6	25 0%
20,400	658	8,200	8,858	11 87	2 92	283	96·9	24·6%
0	658	1,872	2,520	3·38	...	108	...	...

12-inch Steam Centrifugal Pump.

Type.—12-inch centrifugal pump, pumping capacity 2,300 gallons per minute, driven direct by a vertical compound condensing engine.

Engine.—Cylinders, 1 H.P. 6 inches diameter.
„ 1 L.P. 12 inches diameter.
Stroke, 7 inches.
Speed, 210 revolutions per minute.

Pump.—Suction, 8 feet.
Delivery, 7 feet.
Total head, 15 feet.

Speed.	Gallons per hour delivered.	I.H.P.	B H.P.	Lbs. steam per hour.		Efficiency. B.H.P. / I.H.P.
				Total.	Per B.H.P.	
209	2,008	36·25	·9 13	...	...	...
	„	„	„	846	92 6	25·2 per cent.
	„	„	„	821	90	„ „
	„	„	„	821	90	„ „
	„	„	„	813	89	„ „
	„	„	„	813	89	„ „
	„	„	„	846	92 6	„ „
	„	„	„	831	91	„ „
	„	„	„	831	91	„ „

12-inch Centrifugal Motor Pump.

Type.—12-inch centrifugal pump, driven direct by a 600-volt continuous current motor, separately excited, at 100 volts. Speed, 400 per minute. Suction, 8 feet. Delivery, 7 feet. Total head, 15 feet. Capacity, 2,300 gallons per minute.

Gallons per minute delivered.	Watts exciting.	Watts armature.	Watts Total.	E.H.P. absorbed.	B.H.P.	Pounds steam per hour.		Efficiency B.H.P. / E.H.P.
						Total.	Per B.H.P.	
2 274·25	1,000	15,660	16,660	22 33	10 34	499	48 26	46 3 per cent.

Mechanical Stoker Driving.

A chain and bucket elevator, a worm conveyer, and the mechanical stokers of seven Lancashire boilers are driven by a non-condensing vertical engine through a leather belt and one pair of spur wheels, the speed reduction being in the ratio of 12·5 to one of the stoker shaft.

Speed per minute.		I.H.P.
200 ...	Engine running light	·60
	„ and shafting only	2 72
	„ „ and conveyer ...	3 28
	„ „ „ and seven pairs of stokers	4·67

It therefore appears that the power absorbed by the sundry parts of the plant is as follows:—

Speed per minute.		I.H.P.
200 ...	Engine running light	·6
16 ...	Shafting „ „	2·12
	Elevator and worm loaded	·56
	Seven stokers (14 fires, all plungers and fire bars working)	1·40

Note.—Steam consumption trials could not be made owing to the new electrically-driven stoker plant not being out of the contractor's hands.

TRANSMISSION OF POWER BY ELECTRICITY.

By Alexander Siemens.

Read in Section G, September 12th.

The greatest achievement of the century which now approaches its close is the intimate connection that has been established between science and practice, the effects of which are noticeable in every feature of modern civilisation, and in none more than in electrical engineering.

A little over 30 years ago the dynamo-electric machine was invented, which made electrical engineering of practical utility; but long before that time the laws of nature had been discovered by scientific research which govern the flow and the distribution of electric currents, Ohm's and Kirchhoff's laws, and which permit of the accurate measurement of the same, Weber's, Ampere's, and last, but not least, Faraday's researches.

In no other domain of human activity has it ever been possible to attempt the solution of problems with an equal certainty of being able to criticise the proposed methods by the light of well-established scientific rules, and of avoiding unnecessary trouble and expense when these rules showed an error in the reasoning.

This facility of verifying results accounts for the rapidity of the progress of electrical engineering, and for the variety of purposes to which electricity is nowadays applied. Among these transmission of power promises to become one of the most important, and it may not be uninteresting to study its development a little more in detail.

Although telegraph instruments and indicators generally belong, strictly speaking, to this branch of the subject, the term "transmission of power" is usually only applied to cases where electric motors are employed to convert electrical energy into mechanical motion.

The first important development took place in connection with electric tramways starting from the small circular line exhibited in Berlin by Dr. Werner Siemens in 1879. With our present experience there is no need to dwell on the advantages of electric traction in the streets of towns and their suburbs, and there is little doubt that in the near future horse and steam tramways will disappear everywhere.

Up to now cable traction has held its own in all cases, where exceptionally heavy gradients have to be dealt with, but means are devised to overcome such gradients with the help of electric motors, and in this field the ultimate triumph of electricity is also assured.

This great success on tramways has naturally led to attempts to move the trains on the railways by means of electric locomotives, and it is well known that even the heaviest goods trains can be drawn by electric motors as well as by steam locomotives. It would be a fallacy, however, to deduce from this fact the conclusion that it would be advantageous to replace the locomotives on all existing railways by electric motors, as the feasibility of such changes depends ultimately only on economical considerations. The changes may be technically possible, but an alteration can only be introduced if a saving in expense is thereby effected.

This principle governs not only electric traction, but the whole field of human progress, which proves the necessity of investigating

the economical aspects of a problem after its scientific features have been examined and found to be based on sound reasoning.

In the case of transmission of power there are three factors, common to all systems, which determine the cost of the motive power at the place where it is utilised, and thereby indicate what is the proper system to use.

The first factor is the source of the energy that is to be distributed; the second is the means of transmitting; and the third the apparatus for utilising the energy.

With regard to the first point, the electric system is hampered by the fact that the available mechanical energy, however produced, has to be converted into electrical energy, and such a transformation always involves losses, which are avoided where the mechanical energy can be applied direct to the means of transmission.

As the cost of generating electricity decreases up to a certain point with the increase in size of the dynamos, it is desirable so to arrange the whole system that the units of the generating machinery can be constructed large enough to give the most economical results, and so to choose the site of the generating station that all the necessary supplies can be obtained in the cheapest manner.

In spite of the drawback mentioned above, electric transmission of power is applicable, in a great many cases, on account of the unquestionable superiority of the means of distributing electricity over the means of dealing with any other form of energy.

The ease with which the current can be carried over a long distance, the certainty with which the losses can be determined beforehand, and the flexibility of the conductors, constitute advantages which no other system presents, while the inevitable loss of the double conversion, added to the losses in the conductor, militate against the application of electricity in cases where the source of power and the apparatus for utilising the same can be brought close together.

As the efficiency of electric motors has been accurately determined, there is no difficulty in predicting how much of the mechanical energy produced by the original source of power is available for useful purposes, and it is easy to ascertain from time to time that the desired electrical conditions are maintained.

It is well known that over 84 per cent. of the indicated horse-power of a steam engine is available at the terminals of the dynamo in the form of electrical energy, and that electric motors will produce over 90 per cent. of the electrical energy supplied to them in the shape of mechanical power. These high efficiencies were obtained at a comparatively early period, and it was, therefore, obvious that the main advancement in the electric system must be sought in diminishing the cost of the conductors without increasing the loss of energy during transmission.

Guided by the teaching of science, nearly all inventors have attacked this problem by suggesting an increase in the pressure of the current in one form or another. Under the impulse of this tendency the art of insulating electric conductors has steadily improved, and while it was not long ago considered impracticable to work with currents of more than 2,000 volts pressure, there are now a number of successful electric systems employing currents of 10,000 volts pressure, and insulated conductors for even higher pressures can easily be obtained in the market.

More serious difficulties appeared when attempts were made to construct dynamos and motors for high pressure currents, and many ingenious devices have been suggested to overcome or to avoid them.

In the case of alternate currents the employment of transformers permits the use of low pressure generators and motors, while high pressure currents transmit the energy through the conductors, but this advantage is obtained by introducing another loss through the double transformation.

Without much explanation it is easy to understand that the advantage of such a system is the greater the further the source of power, and the motors are distant from each other.

Another advantage of this system is that the transformers have no moving parts, so that they require next to no supervision, and that they do not occupy much space.

If an equally reliable alternate current motor had been invented there is little doubt that this system of transmitting power would be the dominating one at the present time, but unfortunately alternate current motors, up to now, refuse to start without being first synchronised by external means; they are liable to stop abruptly when they are overloaded, and their speed cannot be varied.

A great step towards the solution of the problem was made when the possibility was discovered of combining three alternating currents in such a way that return wires can be dispensed with. This result is brought about by employing three alternate currents, with their phases differing by 120°, so that their sum is at every moment zero. At the same time a revolving magnetic field is produced in the field of the motor, so that its armature can start revolving without being first synchronised.

In certain cases it is not even necessary to supply currents to the armature, in which the currents will be induced by the revolving magnetic field, so that all difficulties of making contact with the revolving part of the motor are avoided.

As in the case of single phase alternate currents stationary transformers can be used with three-phase currents, which therefore present very conspicuous advantages for transmitting power.

On the other hand, a continuous current system is decidedly simpler, and consequently cheaper in first cost and cheaper in maintenance, provided the dynamos and motors can be well enough insulated to permit the use of high tension currents. The transformation losses are avoided, and the motors can be made extremely efficient for large differences in their load, and their speed can be varied without much trouble, both qualities in which the three-phase motors are deficient.

As there are continuous current generators regularly supplying currents at more than 2,000 volts pressure, it is evident that this system can be applied in all cases where the distance between generator and motor is not excessive, and indeed, in most cases where electricity is employed to distribute power in factories, continuous currents are preferred. Such an installation, viz., the electric plant at the works of Siemens Bros. & Co., at Charlton, was described by the author in December, 1894, before the North of England Institute of Mining and Mechanical Engineers at Newcastle-on-Tyne, and since that time very valuable experience has been gained there with regard to the suitability of electric motors for driving machinery.

Six years' work has shown that the system is perfectly reliable, and that the expected great saving in the cost of attending to the motive power has been fully realised.

During the year 1897, the output of the generating station was 1,178,286 B.T.U., or a load factor of ·18.

In May and June this year some tests were carried out to determine the consumption of coal and water per Board of Trade unit, and the output in one week was found to be during day time 21,283 B.T.U., or a load factor of ·35, and during night time 6,047 B.T.U. or a load factor of just under ·10. During these trials Yorkshire hard coal was used, having an evaporation power of 13·8 lbs. of water, as compared with Welsh coal 14·5 lbs.; in day time 5·13 lbs. of coal were consumed per B.T.U., and at night 10·42 lbs., showing the immense influence of the load factor, while the average consumption was 6·55 lbs. of Yorkshire coal per B.T.U.

Allowing for the difference in heating value the 1,178,286 B.T.U. in 1897 were produced by the burning of 3,282 tons of Welsh coal, while the boilers of the central station consumed altogether 6,514 tons.

It is therefore fair to charge half the actual expenses connected with the boilers to the generating of the electric current, while the other half falls on heating the works and driving some steam engines which have not been replaced by electric motors.

The actual expenses during 1897 in connection with the boilers, pumps, and condensers were £8,746, and include coal, carting the same and the ashes, trimming coal and stoking boilers, washing, cleaning and attending boilers, condensers, and economisers, supervision, repairs, gas, sundry stores, 10 per cent. depreciation and 5 per cent. interest.

The present staff to work five return tube and two Babcock and Wilcox boilers consists of one chief stoker, five stokers, one trimmer, and one boy.

For the engine department the total expenses were £1,648, comprising the wages of the engine room staff and of occasional help from the yard department, supervisions, repairs, stores, 10 per cent. depreciation and 5 per cent. interest. The engine room staff consists of three engine drivers, two dynamo attendants, and three electrical assistants, whose time is not wholly taken up with central station work.

In these charges no account is taken of the water, most of which is used in the India-rubber department before it is transferred to the boilers. The total amount spent on such water was £234 for the year 1897, and one-third, or £78, should be charged against electricity. According to these figures the actual cost of electricity was, in 1897:—

Expenses in boiler department...	£4,373
„ engine „	1,648
„ for water	78
Rent, taxes, insurance, and salaries	220
1,178,286 B.T.U. total cost	£6,319

or 1·287d. per B.T.U., or 0·96 per electrical H.P. at the switchboard of the station.

For the maintenance of the cables no expenses at all were incurred, but for depreciation and interest 7½ per cent. should be charged on the capital outlay, which was in round figures £3,000.

In connection with the motors the expenses were £2,063, comprising repairs, stores, labour, 10 per cent. depreciation, and 5 per cent. interest. A further charge on the motive power is the 5 per cent. loss in the conductors, and 10 per cent. loss in conversion from electrical into mechanical energy.

Taking all these figures together, we arrive at the total cost of motive power during the year 1897, viz., £9,900, or 2d. per B.T.U., and 1·71d. per brake horse-power per hour exerted by the motors.

It is not pretended that these results are the best obtainable. They may, however, be utilised for drawing some general conclusions, which apply to transmission of power by electricity generally.

For this purpose the total of £9,900 has to be sub-divided under the heads:—

(*a*) *Standing Charges.*—Depreciation, interest, payment of rates and taxes, rent, general charges, and loss in conductors and conversion.

(*b*) *Fuel.*—Coal, and carting the same.

(*c*) *Labour and Supervision.*—Actual wages paid in connection with boilers, engines, and motors, also part of foreman's wages.

(*d*) *Stores.*—Mainly oil and waste, also water, the charge for the latter is, however, exceptionally low, as explained above.

(*e*) *Repairs.*—The charges of the fitters and other departments for work done.

Arranged under these heads the total charges for the brake horse-power given out by the electric motors are—

(*a*) Standing charges	£4,869	or 49·1	per cent.
(*b*) Fuel	2,654	„ 26·8	„
(*c*) Labour...	1,183	„ 12·0	„
(*d*) Stores	595	„ 6·0	„
(*e*) Repairs	599	„ 6·1	„
Total	£9,900	100·0	„

This shows that, roughly speaking, the standing charges account for half the expense, fuel for a quarter, labour for one-eighth, and repairs for one-twentieth, the stores making up the total.

In addition, it should not be overlooked that the cost of conductors and the loss of energy in them is naturally low, as the motors are comparatively close to the central station. Wherever they are far apart the standing charges would preponderate still more.

Of the 49·1 per cent. charged as standing charges, 36·1 per cent. are unvarying, while 13 per cent. represent loss in leads and in conversion, and these will increase with an increasing output.

For instance, if the output of this particular plant were doubled so that the load factor would be ·38, the expenses would be for, say, 2,400,000 B.T.U.:—

Standing charges	£6,162 =	38·00	per cent.
Fuel	5,308 =	32·65	„
Labour	2,366 =	14·60	„
Stores	1,190 =	7·35	„
Repairs	1,198 =	7·40	„
Total	£16,224	100	„

This is equal to 1·62d. per B.T.U. at the terminals of the switchboard, or just under 1·4d. per brake horse-power per hour given out by the motors.

Of the standing charges 22 per cent. represent depreciation and interest, while 16 per cent. cover the losses in leads and in conversion.

A comparison between these two results shows again the importance of increasing the load factor to diminish the expense per unit of work done, or, in other words, if power is to be transmitted by electricity it is above all things necessary to use it as constantly as possible.

Conversely if in any particular instance power is wanted only at intervals and for short periods, it can safely be assumed that no economy can be effected by introducing transmission of power by electricity. Similar considerations determine for the workshop, whether it is more advantageous to drive a particular machine by its own electric motor, or whether it is more economical to group a number of machines together, driving them by belts from a shaft to which an electrical motor is attached.

Bearing in mind the property of electric motors of not absorbing more current than the load at each moment demands, and their high efficiency even at one quarter of the full load, it will in most cases be possible to group machines together, especially smaller ones, as the cost of a countershaft and belting is in such cases less than the difference in the cost of one large motor and several smaller ones with all their accessories.

The most useful field for electric motors in workshops is without doubt their application to movable machinery such as cranes, travellers, and drilling tools; a description of which need not be entered into.

Next to the importance of having constant work for the plant is the question of fuel consumption. Besides using the most economical boilers and engines, the site of the power plant should be selected so as to secure the fuel at the lowest possible cost.

Whether water-power would be cheaper than steam, cannot be decided for all cases, as the answer depends on the amount of capital outlay required to secure an adequate supply of water at all seasons of the year, further on the price of coal and other well known considerations. At any rate it is very remarkable how very few localities can be found where a sufficient water supply may be depended upon all the year round.

An obvious solution of the problem, how to obtain cheap fuel, is evidently to erect the plant for generating electricity close to a coal mine, and to distribute power to the various works which usually are found in the neighbourhood.

Such an installation has been erected at Brakpan, in the Transvaal, and the electricity is conveyed from there along the Witwatersrand to various mines and railway stations up to Johannesburg, which is about 30 kilometres (19 statute miles) distant from Brakpan.

The generating plant was erected near a small lake, so as to secure water for condensing purposes all the year round, about 3 km. (2 statute miles) from a coal mine, with which it is connected by a private railway line, and all the latest improvements in the shape of mechanical conveyers and stokers were adopted to reduce the price of the fuel and the cost of labour.

Besides a separate plant for supplying all the auxiliary motive power and the station lighting, the works contain four main steam dynamos of 1,000 H.P. each, which deliver three-phase currents at 750 volts to transformers, which raise the pressure to 10,000 volts. The current then enters the overhead main line of conductors, which is altogether about 40 km. (25 statute miles) long and has branches to the various mines, as circumstances require.

Each conductor consists of two bare strands of copper wire, each 70 sq. mm. in section, and elaborate precautions have been adopted to prevent these six strands from falling to the ground and from coming in contact with other wires crossing the main line.

Some trouble was experienced to protect the system against lightning, and it has been necessary to construct special apparatus before this difficulty could be overcome.

At the various mines tranformers reduce the pressure of the current according to the purposes for which it is to be used, and they employ motors, varying in size from 1·5 H.P. to 250 H.P.

In the month of July, 1895, the works at Brakpan were commenced, and on January 27th, 1897, the first steam dynamo commenced working. Since then the works have steadily been added to, but the data as to cost can obviously not be taken as a guide for other cases, as the regular working of the full plant has not yet settled down properly.

A somewhat similar system of distributing power over a district has been in operation near Waldenburg, in Silesia, for the last two years. In this case the generating plant has been erected at the pit mouth, and it consisted, at first, of four steam dynamos, each of 300 H.P., two of which produced three-phase currents; the third, continuous currents, to work a tramline about 22 km. (14 statute miles) long, while the fourth steam engine is coupled to one three-phase and one continuous current dynamo, serving as a standby for both systems.

For a radius of 4 km. (2½ statute miles) the three-phase current is distributed at a pressure of 3,000 volts, at which it is generated, but for greater distances the current is transformed up to 10,000 volts.

Owing to the success of the enterprise, two large three-phase generators of 1,000 H.P. are to be added, as soon as they can be completed, and six more of the same size will be taken in hand in the near future.

The charge to the public for electricity is in the district receiving current at 3,000 volts—

For lighting purposes 50 Pf. (= 6d.) per B.T.U.
For motive power and heating 15 Pf. (= 1·8d.) per B.T.U.

In the places supplied by the 10,000-volt currents, the charges are 20 per cent. higher, but large consumers receive a discount according to the amount of current they use, amounting to 35 per cent. in cases where the value of current taken exceeds 10,000 Mk. (£500) per year.

At these prices the 1,200,000 B.T.U. used in 1897 in Siemens Bros. works at Charlton would have cost about £7,000, even if the higher prices of the 10,000-volt district had been paid.

It is characteristic for this country that these examples of transmission of power by electricity over a large district had to be taken from foreign practice.

However enterprising and progressive the individual Englishman is, when a novelty can be introduced only by the co-operation of a municipality, of a county council, or, worst of all, of Parliament, everybody appears to consider it a patriotic duty to throw obstacles in its way, and in most cases it is quite impossible to find out who benefits by such action.

After a while the public discovers that the introduction of the novelty would be a great convenience, and an agitation is set on foot to remove the obstacles which were, in many cases, introduced only to satisfy prejudices. Let us hope that a similar fate will not befall the transmission of power by electricity.

THE APPLICATION OF THE ELECTRIC MOTOR TO SMALL INDUSTRIAL PURPOSES AND ITS EFFECTS ON TRADE AND ON THE COMMUNITY GENERALLY.

By Alfred H. Gibbings, M.I.E.E.; President of the Municipal Electrical Association; City Electrical Engineer, Bradford.

Read in Section G, September 12th.

The electric motor is rapidly becoming the most favoured medium for the transformation and transmission of energy for all industrial operations whether on a large or small scale. This is due to the paramount advantages it possesses over any other method of utilising potential energy. These advantages are well known to electrical engineers, but indifferently appreciated by a large number of mechanical engineers, and almost unknown by the general manufacturer and tradesman. To the last of these three, the general manufacturer and tradesman who is using machinery driven at present by steam or water-power, the electric motor must in the days to come prove of exceptional value; and yet, strangely enough, very little effort has hitherto been made either by the motor maker or by the managers of electricity supply undertakings to open up this very wide and lucrative field of enterprise. There is no necessity to enumerate here the many excellent and distinctive features which the electric motor possesses. The intention in this paper is rather to consider the reasons why its application up to the present time has been confined to a few special trades and manufactures. We are familiar, for instance, with electrically-driven pumps, electric hoists and cranes, electrically-driven machine tools, and electric power transmission in works—cases in which the generation, transformation, and application occur practically under one roof. Many manufacturers and constructional engineers, wisely and readily incurring additional capital outlay with the object of securing more economical production, have adopted electric motors, which do not entail the use of endless and power-absorbing shafting and countershafting. As yet, however, it cannot be said that the electric motor is in general use, or scarcely other than just past the threshold of its future domain. I shall endeavour to show how large a sphere of influence it is destined to fill. The smaller producer and tradesman, to whom motive power in some form or other is essential, and who feels more acutely than his larger *confrère* the effects of competition, has in the great majority of cases still to put up with very much more cumbersome and very much less efficient means of power production. Almost every town with any pretension to size and importance has its own large staple industries, as well as many minor industries and businesses, requiring the use of other power than hand power. There are also some handicrafts which are at present unavoidably confined to hand power, because steam, gas, oil, and hydraulic power are each and all inapplicable. There can be little doubt that the electric motor would be welcomed and readily adopted in these cases if only its simplicity and adaptability were known and understood. I will give a somewhat full, though by no means exhaustive, list of these trades:—Acid manufacturers, aerated water manufacturers, agricultural implement makers, automatic electric signs, back

and vat makers, bag makers, aerated bread makers, basket makers, bicycle makers and repairers, boiler makers, book binders, boot makers, boot polishing, bottle cleaners, bottle makers, box makers, brass finishers, brush makers, cabinet makers, carpenters, carpet beaters, coach builders, coffee grinders, coopers, cutlers, cranes, dairymen, dentists, engineering workshops, engravers, fans for ventilating and other purposes, forage cutters, forced draught, founders, grain elevators, hoists, hair-brushing machinery, laundries, lifts, lithographers, millwrights, musical instrument makers, oil refiners, opticians, organ builders, organ blowing, packing-case makers, paper makers, pianoforte makers, picture-frame makers, presses, printing machinery, pumping, racket makers, rope makers, sack makers, saddlers, sausage makers, saw makers, saw mills, scientific instrument makers, seed crushers, sewing machines, shop fitters, smallware manufacturers, smelters, smiths, snuff manufacturers, soap makers, stick makers, stuff manufacturers, sugar refiners, surgical instrument makers, theatrical machinery, timber merchants, tinplate workers, tobacco cutters, tool makers, toy makers, turners, umbrella makers, undertakers, watch makers, wire drawers and workers, zinc workers, &c. Other special and local industries will occur to you without enumeration, which can be placed in the same category.

The advantages of driving electrically in some of these cases are of a very distinctive character, and it will be well to consider briefly one or two prominent examples.

Boiler Makers.—The practice of drilling all rivet holes in boilers with the overlapping plates *in situ* is an operation which is much more rapidly, readily, and economically performed if the drilling machines can brought to the work instead of taking the shells to a fixed machine tool and there adjusting them for every fresh set of holes to be drilled.

Book Binders, Boot Makers, Cutlers, Presses, Saddlers, Saw Mills, Smiths, &c.—These trades are instances in which several machines are frequently employed, but of which intermittent use only is required. By any method of driving other than by electricity, it is incumbent to employ lines of shafting and countershafting, and to keep these in continual motion in order to use any one machine when required. In such cases, by direct coupling to the machine to be driven, and by its unequalled facility for starting and stopping, the electric motor has unique and all-important advantages.

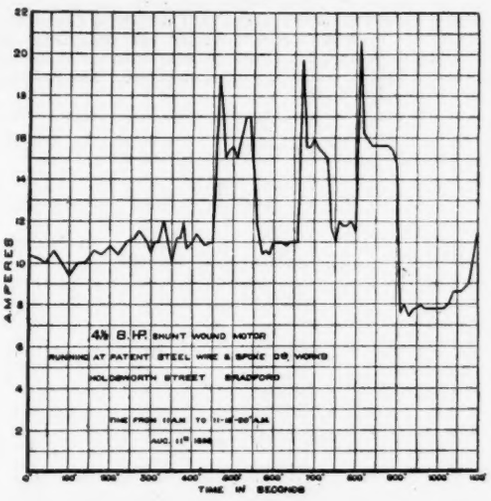
Letterpress and Lithographic Printing.—This class of machinery has been successfully operated for upwards of two years by electric motors applied direct to the main driving shaft of the machine or by toothed gearing. Since the first attempts were made many improvements have been introduced, until, at the present time, nearly all the leading houses in the trade have either adopted the system of single machine driving in its entirety, or some such modification of it as best seems to suit their particular methods of working. It is doubtful if printers realise the immense loss that occurs by the old method of driving. Wherever the system of shafting and belts is used to transmit the energy generated by the driving engine there is a great loss of power; not only so, but a mass of machinery and gearing has to be kept wastefully running whilst possibly only one or two machines may be utilised. In one case where tests were made it was found that the shafting and belts absorbed 56 per cent. of the actual power generated by the engine. In this industry the extremely steady and even motion imparted by the rotary action of the electric motor is also an important feature.

Cranes and Hoists.—In almost every town there are warehouse and other cranes, and passenger and goods hoists, in general use. The advantages of the electric motor for these purposes are (1) the possibility of placing the motor close up to its work; (2) direct coupling or reduction gearing of high efficiency; and (3) the economy resulting from the power used being practically proportionate to the work done.

There is no need for me to give you further examples in detail. The application of ordinary mechanical tests for efficiency, and the experience already obtained by the substitution of electric motors for other methods of power production, have proved beyond doubt its exceeding adaptability and superiority. Notwithstanding all this, however, many obstacles yet remain to hinder its general adoption by what may be termed the commonality of the manufacturing world, and among the principal may be mentioned the following:—

1. The extreme aversion to innovations which characterises the industrial world in this country especially.
2. The existence of other motors in good working condition.
3. The unsuitability of alternating currents of electricity for motors where the power required exceeds 2 H.P. or 3 H.P.
4. The want of capital to lay out in new machinery; and
5. The want of confidence in the electric motor by the non-technical manufacturer.

The first and second points do not require any further commentary or elucidation, and I shall therefore dismiss them without more observation. With regard to the third point, it is much to be regretted that the alternating current motor is not yet capable of doing the same work as a continuous current motor. The energy required to operate either type must, of course, be derived from some source—usually a steam dynamo—from which distribution mains carry the current in any direction; and as this is the most efficient method known of transmitting energy and the motor the most efficient medium for transforming it into useful work, the principle has been applied in the workshop as well as for public supply. There is no need to dwell upon the advantages of the centralisation of steam power, nor upon the universally-admitted fact that electricity for power purposes can be supplied from public lighting mains at a very low cost. But in addition to these there is one equally important advantage of deriving power from public mains from the user's point of view—I refer to the actual resultant taken on the average of the varying loads, which is characteristic of the electric motor, and the facility for instantaneously switching "on" and "off" as required. This feature is illustrated in the accompanying curve, which has been taken from the most modern machines. It will be seen that the maximum horse-power was 6·4, and the duration of time 18 minutes, which, if the maximum power had been a constant load, would represent approximately 2 horse-power-hours. But after the resultant has been carefully obtained with a planimeter, the actual horse-power-


AMPERES
4½ B.H.P. SHUNT WOUND MOTOR
RUNNING AT PATENT STEEL WIRE & SPOKE DE WORKS
HOLDSWORTH STREET BRADFORD
TIME IN SECONDS

hours are found to be 1·06. This difference between the maximum horse-power required and the mean horse-power used is rarely taken into account or even understood by many small power users—it is a most difficult thing to get them to appreciate it.

The chief obstacle to the more rapid adoption of electric motive power, especially in the case of small tradesmen, throughout the country is undoubtedly the want of capital to purchase the necessary motor; but where the power to purchase exists, the buyer will probably have little or no experience or knowledge of electrical matters to guide him in his purchase; if his means are at all limited he will be tempted to venture on a cheap line, and become the dupe of those who simply make to sell. The solution of these difficulties—which to my mind appears the most satisfactory, because it is the one fraught with the greatest advantages to all concerned—is that the owners of electricity supply undertakings, whether a public company, municipality, or other local authority, should themselves purchase good, reliable motors, and let them out on hire. Antecedently this scheme may appear a sort of parental *régime*, but it is suited to present circumstances at any rate, and experience proves it to work well. Unfortunately, all local authorities have not got powers to borrow money for this purpose, although it appears from the Electric Lighting and Public Health Acts that borrowing powers may be granted by the Local Government Board for works of a permanent nature. Electric motors do not yet come within that category, although gas stoves do, a legal decision having been given in their case. All future municipal Parliamentary Bills should therefore contain clauses which would confer such powers and secure freedom of action in this respect. I do not propose here to run into elaborate details with regard to terms or general scheme of hire, but I may say that in Bradford we have found a rental charge of 10 per cent. upon the initial cost of each motor to be amply sufficient. This is made up of 3 per cent. for interest, 3 per cent. for sinking fund, and 4 per cent. for depreciation and contingent expenses. The Bradford Corporation inaugurated their scheme of hiring (in which also arc lamps are included on similar terms) in November, 1896, and the following table will show the extent to which these facilities have been appreciated:—

Year.	Number of motors supplied from Corporation mains.		Board of Trade units sold per annum.
	Owned by consumer. Not on hire.	Owned by Corporation. On hire.	
1895	35	*nil.*	35,919
1896	23	7	54,972
1897	14	39	117,176
Six months only, 1898	6	42	63,820

From this table it will be seen that the increase in electricity supplied for motive power in 1896, in which year the hire system had been in operation for two months only, was 19,053 units; in 1897 the increased sale over 1896 was 52,204 units, and in the present year the increase is likely to be 62,834—or a sale of 180,000 units, or 53 per cent. over 1897.

Hitherto the supply has been confined to small power uses—such as cranes, hoists, fans, pumping, aerated water making, electric advertisement signs, and similar purposes. During the last month, however, so popular has the electric motor become, that applications have been received from a large spinning and weaving firm, two

foundries for blower purposes, an engineering shop requiring 50 H.P., and a saw mill requiring about 20 H.P. I referred a moment or two ago to the want of confidence of the small power user in the electric motor; that confidence, however, is soon gained. It is gratifying to be able to state that several consumers in Bradford who originally applied on the hire system, and at the time with much trepidation and many inquiries, have since decided to purchase the motors outright. The accompanying table has been compiled from replies to an inquiry which I made recently of each municipal electrical engineer where the continuous current system has been adopted, and from it may be gathered the extent to which electric motors driven from electric lighting mains have been employed. The figures given are up to the end of 1897.

Town.	Population.	Number of motors supplied.	Total H.P. of motors.
Aberdeen	140,000	14	65
Bradford	231,261	119	470
Brighton	122,310	100	Not given
Belfast	320,000	Not given	165
Birkenhead ...	110,000	4	15
Bury	63,000	5	12
Blackpool	40,000	7	7
Burnley	90 000	8	32
Chester	37,100	20	70
Dewsbury	29,847	4	16½
Dundee	169,000	15	20
Edinburgh ...	295,000	167	343
Glasgow	750,000	37	131
Hull	213,000	14	46
Lancaster	38,224	28	80
Liverpool	641,063	57	152
Manchester ...	505,368	257	696
Norwich	101,000	61	120
Nottingham ...	213,877	18	50
Oldham	148,000	11	60
Southampton ...	90,000	18	23
Shoreditch ...	124,000	31	434
Sunderland ...	147,000	23	240
Wolverhampton ...	92,000	2	3
Whitehaven ...	20,000	...	...
Walsall	72,000	7	13½

I have endeavoured in this paper, and in the necessarily limited time and space at my disposal, to place before you the outlines only of a method of extending the adoption of electric motive power by the general manufacturing community. Those who have the management of public electricity supply undertakings know full well the value of the electric motor as a factor in the reduction of the working costs, which is also the principal argument for the combined working under one roof of electric lighting and electric tramway systems. But there are other and probably greater effects which the electric motor will produce with its more complete adoption in the near future—I refer to the beneficial effects upon the trade and productions of the country, and the hygienic and social effect on the community generally. In the first of these aspects it is possible to foresee the revival once more of a number of small and independent industries, such as existed, but under very different conditions, in former years. The possibilities are already being grasped by the artisan in France, Germany, Switzerland, and the United States. By the aid of the electric motor he begins to find that he can at least hold his own in competing with immense manufacturing concerns and combinations; he has a practically unlimited available power at his own door—which is a great boon to the artisan, and one which offers him an inducement to become his own master. In a very small and limited degree the gas engine has already accomplished something in this direction, but its many imperfections, its cost, and the fact that it has never been available on the hire system, have kept it more or less in the background. The effect of hiring-out is thus mutually advantageous, and its natural tendency is to create fresh demands; in fact, the municipality which includes this scheme in its electric light undertaking offers a great inducement to the influx and establishment of new industries within its area. With a more complete return to a multiplicity of industrial operations, there may also revive some neglected trades—such as those which have passed from us to other countries, and which now form our imports. From an hygienic point of view, the electric motor is far and away the best; it is cleanly in its working, gives off no deleterious gases, and displaces the boiler and smoky chimney. One of the ultimate results must also be the raising of the status of the working part of the community. By becoming his own master the artisan gains self-respect, becomes more resourceful, and therefore a more important member of society; and the more intelligent interest which he will display in his business must appreciably affect the general welfare of the country.

(*British Association Papers continued on page* 427.)

Correspondence Instruction in Electrical Engineering.—The Electrical Engineer Institute of Correspondence Instruction, which is conducted under the auspices of the New York *Electrical Engineer*, has opened a branch in London at 2, Warwick Street, Regent street, W. Mr. C. P. D'Oyly is the representative for Great Britain and Ireland, and he will send a copy of the free pamphlet on "Can I become an Electrical Engineer" to those who communicate with him.

PROF. AYRTON'S ADDRESS AT THE B.A.

As President of the Mathematical and Physical Section of the British Association, Prof. Ayrton delivered an address of singular scope and suggestiveness. Section "A" this year is associated with the International Conference on Terrestrial Magnetism and Atmospheric Electricity; it was, therefore, to be expected that the President would revive the question of the influence of electric supply circuits on the instruments used for terrestrial magnetic observations. He did so by remarking, very truly, that the electric traction engineer seems bent on converting our maps of lines of force into maps of lines of tramway; and, moreover, that the same cause seems destined in time not only to to annihilate observatories near towns, but seriously to interfere with the existing telegraph and telephone systems. The principle of "the survival of the fittest," or as Prof. Ayrton puts it, "the survival of the strongest," here manifests itself in one of its less pleasing forms, the offspring slaying the parent, the engineer ousting the magnetician; but the Conference can be trusted to discuss the matter with great fairness, for it numbers among its representatives "persistent types" both of the assailant and the assailed, moderated by a few of those amphibian existences who, as magneticians, weep over what, as consulting electricians, they assimilate.

Prof. Ayrton, continuing his address, spoke at some length upon the advantages likely to accrue from the publication of indexed and co-ordinated abstracts of current scientific literature. This work, it will be remembred, was begun by the Physical Society in 1895, with financial aid from the British Association. The abstracts brought into a focus all that was best worth notice in foreign journals relating to pure physics. But the question of ways and means, and the desire to extend the abstracts to British publications and to technical subject matter, induced the Physical Society to join hands with the Institution of Electrical Engineers. *Science Abstracts* is the result; its aim, as expressed by Prof. Ayrton, is to provide, in a single journal, a monthly record, in English, of the most important literature appearing in all languages on physics "and its many applications." From the point of view of a technical journal, we fully appreciate the advantages of a monthly synopsis of contemporary publications on pure physics; not the least of those advantages is to learn into what a small paragraph the gist of a lengthy paper can be put; indeed, we are sometimes inclined to say, "How much greater is the half than the whole!" If, however, in addition to physics, "*its many applications*" are to be simmered down and labelled on the same plan, the monthly copies of *Science Abstracts* will soon acquire the dimensions of a London and Suburban directory. At present, the dimensions are restricted by limiting the number of subjects; thus confining the advantages within a comparatively narrow range of industries, to the neglect of very many important branches of engineering. The spirit of competition requires that a careful watch should be kept on foreign industrial methods, and if they cannot all be recorded in detail, there is no reason why they should not all be brought under an index. It appears to us that if the intention is to include, in one journal, references to all publications on physics "*and its many applications*," something akin to a monthly *Royal Society Catalogue* ought first to be attempted—a mere index of subject matter. This would in no way interfere with the excellent services of *Science Abstracts*, which would continue as it began—a contemporary history of pure physics.

In once more urging the necessity for a National Laboratory, Prof. Ayrton deduces some curious instances to show that many important theorems have been thought out by mathematicians while seeking an explanation for technical and more or less trivial problems. Thus "the gaming table gave us the whole theory of probability, Bernoulli's and Euler's Theorems, and the first demonstration of the Binomial Theorem." It appears also to have suggested the method of Least squares and the Integration of Partial Differentials with Finite Differences. Hence, he concludes that, failing the establishment of a National Laboratory, a Technical Institution for Standardisation should suggest valuable lines of research in the realm of pure physics. We are led, by the Professor's

instances to ask, "Might not a gaming house afford the same stimulus?"

The last half of the address is taken up with an account of an investigation of the sense of smell. Prof. Ayrton finds, experimentally, that the generally accepted idea that metals have associated smells, is only conditionally true. With certain metals, such as commercial aluminium, brass, bronze, copper, German silver, gold, iron, silver, steel, tin, and zinc, the smell vanishes as the surfaces are more and more cleaned. The propagation of smell is a subject closely allied to diffusion, but diffusion alone is too slow in its action to explain all the phenomena. We await with interest Prof. Ayrton's further experiments in this neglected branch of physics. The smell of selenium (or its oxides?) always seemed to us to have a real existence, in no way dependent upon the surface hydro-carbons; it would probably be a good metal with which to investigate the problem.

CORRESPONDENCE.

The Ideas of Mr. Kershaw on Ozone.

In good faith, Mr. Kershaw ought to have refrained from his systematic negation of the properties of ozone, until the efforts of the ozone makers have proved unsuccessful, and his hostility towards ozone—this new branch of the electrical industry—about which Nikola Tesla wrote me two years ago, "that it was in its infancy, but capable of great development," does not seem to show the generous mind of a man fond of scientific progress.

There are no arguments in his disparagement, which is merely hypothetical, and cannot be based on facts, since he has never worked, nor even seen at work, a commercial ozoniser, and has, therefore, never been in a position to test the properties of ozone. I published in 1893 a pamphlet on "Ozone: Its Production, its Commercial Applications," to which almost all the English press devoted notices and articles; there was not, however, a single writer who taxed me with attempting to "make a boom" on my apparatus, which I described then as giving 18 to 20 grammes of ozone per H.P.-hour.

In 1897 I had a paper read at the Society of Chemical Industry, in which I spoke of an improved ozoniser giving 35 grammes of ozone; nobody said that I was trying to make a boom.

I have since found that high tension was prejudicial to the formation of ozone, and I devised a more efficient ozone generator, which was the object of two articles in the *Industrie Electrique* (May, 1898), and the *Electricien* (June, 1898), in which I discussed the theory of the formation of ozone, and explained the new principles on which is based my new apparatus, *i.e.*, the use of large point bearing grids, the advantage of a large surface of electrodes, and of relatively low tension in order not to have any rise of temperature in the ozoniser, no nitrous compounds, and a greater yield of ozone.

Beyond these two articles, I did not write a single line in the Foreign and English papers about my apparatus, but in June last I published an illustrated catalogue which was sent to the press, the main object of which was to say that we are prepared to supply commercial ozonisers having a capacity of half a kilowatt, one kilowatt, or more.

Is not this legitimate?

What right has Mr. Kershaw to speak of *sensational and doubtless inspired paragraphs relating to the applications of ozone which appeared during this summer?* Is the article published a fortnight ago in the ELECTRICAL REVIEW also an inspired article to boom ozone?

I have no hesitation in saying that my rancorous critic, as a member of the electrical profession, ought to be ashamed to use such improper language. What will Mr. Kershaw say when I tell him that, within four or five weeks, I will have ready a book of some 400 pages on the formation of ozone and its applications.

Again a boom, a big boom!

Had Mr. Kershaw done anything of which he could be as proud as I am of my ozonisers, which can give 100 grammes of ozone per H.P.-hour, he would certainly have written more about it than I did about my apparatus. I will give him this sound advice: never to write on *electrolysis* or any other subject of which he has no practical knowledge.

Now that I have protested against the insinuation that I have attempted to make a boom about my apparatus, Mr. Kershaw can write more letters. I will not reply.

Mr. Kershaw has a bias against ozone; he has no experience of it, but he hates it. He reminds me of the man who did not like melon, and was saying: "I do not like melon, and I am glad of it, because, if I did like it, I would eat some, and I cannot bear it."

E. Andreoli.

Dynamo Fault.

I thank you for your reply to my letter in your issue of 9th inst., and am glad to see that you agree with my views.

It is by no means improbable that your original suggestion that the field-magnet resistance of "Abnormal's" dynamo is too high is the correct explanation of the trouble described by him, but from the context you apparently regarded such excessive resistance as being consequent on the unusual lowness of the speed.

You agree with me that if a dynamo is properly designed for a given voltage, then the field resistance will not be affected by the speed at which the armature is to run, and I am therefore at a loss to understand on what grounds you can suppose that "in order to get the low speed" the designer of "Abnormal's" dynamo has made his field-magnet resistance too high for proper excitation.

If I have misunderstood your reply to "Abnormal," then it would be of interest to know to what the bracketed words "in order to get the low speed" do refer. In the absence of fuller details, I made no attempt to discuss the bad working of "Abnormal's" dynamo, but the want of clearness in your reply to him (due possibly to its brevity), induced me to raise this particular point as being of general interest in connection with dynamo design.

The case described by N. C. Woodfin is easily understood. He could, however, have charged his battery from the dynamo, even with the two shunt coils in series, by connecting them on to the battery before the armature, but the course he adopted was preferable.

H. C. L.

Electrical Canal Haulage.

I have read your leading article on this subject with considerable pleasure and instruction. It is, however, necessary to say that this is a joint invention; indeed, I think I am justified in saying that my co-patentee, Mr. George Cawley, is responsible to a greater extent than myself in the final form which the system has taken.

B. H. Thwaite,
per H. A.

Transmission of Thought.—An Electrical Analogy.

It is interesting to note that Sir W. Crookes, in his presidential address, agrees with "Delta," *vide* ELECTRICAL REVIEW, April 8th, 1898, to the effect that there is some analogy between the cause and effect of Hertzian rays and the strong impulses that are occasionally transmitted between human subjects in strong sympathy with each other, but separated by many miles.

This subject of transmission of thought is so mysterious that any correlative evidence of explanation is very welcome.

Hertz Rays.

Re The Relative Costs of Copper, Aluminium, and Iron, when used as Electrical Conductors.

The article by Mr. John B. C. Kershaw, which we found in your last issue, has greatly interested us, as also did the previous articles treating of the same subject. Will you allow us to point out some considerations we arrive at when the matter is looked at from a more practical point of view.

First of all, the question must be limited to aerial conductors, because it is obvious that aluminium and iron cannot be entertained for one moment as materials for underground conductors. Copper has always been, and will

continue to be, as long as no cheaper metal with a higher or as high a conductivity will be found, the only possible cable conductor for practical purposes. Iron as well as aluminium would require to have more than five times the volume of copper to yield the same effective resistance. Therefore it is to be guessed what enormous dimensions and prices of cables we would arrive at by using those metals. Consequently the comparison must of necessity be restricted to overhead wires.

We presume that Mr. Kershaw has principally in view conductors for heavy currents, otherwise we would not understand his saying, when speaking of iron, "though its weight, as compared with copper and aluminium, prevents its use for overhead lines;" because the use of iron for overhead telegraph lines cannot possibly be ignored, although copper has been substituted for iron in the construction of telegraph lines to some extent.

We further wish to point out that it serves no practical purpose to compare the prices of the different metals, as Mr. Kershaw does, in the crudest state. The only practical comparison is that of the finished wires as they are strung on the insulators. And as iron wire has to be protected against oxidation by a coat of zinc, and the drawing of the wire increases its low value more considerably in proportion to that of copper or aluminium wire, the result of the comparison is necessarily different to what Mr. Kershaw makes it.

We think the following prices will be found reasonable, such as the respective wires can be bought at present:—

Copper wire	7d.	per lb.
Aluminium wire	16½d.	„
Galvanised iron wire with 16·4 % conductivity	1 75d.	„
„ „ „ „ 12 5 % „	0·9d.	„

Therefore, supposing Mr. Kershaw's figures as to specific gravity and conductivity to be exact, but inserting the prices as stated above, we arrive at the following results:—

Copper and aluminium—

$$\frac{8{\cdot}93 \times 7 \times 59}{2{\cdot}68 \times 16{\cdot}5 \times 100} = \frac{100}{120}$$

Copper and iron, with 16·4 per cent. conductivity—

$$\frac{8{\cdot}93 \times 7 \times 16{\cdot}4}{8{\cdot}10 \times 1{\cdot}75 \times 100} = \frac{100}{138}$$

Copper and iron, with 12·5 per cent. conductivity—

$$\frac{8{\cdot}93 \times 7 \times 12{\cdot}5}{8{\cdot}10 \times 0{\cdot}9 \times 100} = \frac{100}{93}$$

so that, commercially, aluminium comes out 20 per cent. dearer than copper; iron of 16·4 per cent. conductivity, 38 per cent. dearer; and iron of 12·5 per cent. conductivity, 7 per cent. cheaper.

As to the use of aluminium it must not be overlooked that its low density and low tensile strength exclude its use for overhead purposes, as far as the present state of the art goes. Its strength may be increased by allaying it with other metals, but it is to be feared that then its conductivity will be considerably reduced and its specific gravity increased.

Per Pa. **Felten & Guilleaume.**
C. Steven.

Sole Agents: W. F. Dennis & Co., 23, Billiter Street, London, E.C.

ELECTRICITY AND MINES DRAINAGE.

The Institution of Mining Engineers commenced its ninth annual general meeting in Birmingham on Tuesday.

Mr. E. B. Marten and Mr. Edmund Howell, in a paper on "The South Staffordshire Mines Drainage Scheme, with Special Regard to Electric Power Pumping," said that any one who was familiar with the Black Country some 30 or 40 years ago must have wondered at the number of large pumping engines required to keep the mines free from water, and could not fail to notice the manner in which the taking out of the remarkably thick coal seams for which this district was famous had broken the surface of the ground, and so sunk the beds and banks of the rivers and watercourses in all directions as to create large sheets of water in numerous places where water ought not to be. Pumping the water at one mine to let it down into another near it was so obviously unscientific, that much effort was was made to find a remedy. Under the auspices of the British Association, who visited Birmingham in 1865, statistics were gathered showing that about 50,000,000 gallons of water were raised from the mines daily, and the calculation soon proved that the pumps were lifting the same water over and over again. The state of the public rivers and streams was found to be deplorable, and the canals and canal-basins were also so much pulled about by mining as to overflow, and so contributed much water to the mines. In times of flood from heavy rain large areas were so covered with water that the streams and canals could not be distinguished. Parliamentary powers were sought in 1872, and such was the general fear of the loss of such quantities of coal as were threatened with hopeless inundation that the necessary powers were readily granted, the first South Staffordshire Mines Drainage Act being passed in 1873. Help came from many quarters, and some rather unexpectedly. The canal companies, although much affected by the powers sought, gave general support, with the hope that with the measures that would be taken the frequent and expensive litigation as to flooding of mines would cease. The paper dealt more especially with the surface (75 square miles), and more particularly those 32 square miles of it called the Tipton district, where electric power is proposed to be used. In this district there were raised from the 32 square miles 36,000,000 gallons of water per day by 120 engines. Very little progress was made while the old pumping engines, over which the commissioners had only limited control were worked, but when they put and also acquired a few of the best of the old ones direct control made more economic working possible. Since 1873, thanks to the surface works, the mass of water to be dealt with had so decreased that the daily quantity has been reduced to 9,000,000 gallons, or only one-quarter of what it was at the commencement. This 9,000,000 gallons, however, did not come to the pumps sufficiently freely to drain the mines to the level of the coal to be worked. It was desired so to further improve the surface works in extent and efficiency as to reduce the "come" from the mines to only 6,000,000 gallons per day, and to pump from some of the drowned pounds by means of a few smaller and semi-portable engines. As the collieries began to be worked, after being freed from water, underground connections would be made. Thus the original plan for concentrating the water would become effected in a natural way, and the water would be brought to the present pumping engines, which were fixed in exactly the right places, and were fully equal to the work. In 1895 a combined scheme for draining the mines and the surface was brought out. It proposed the establishment of two main pumping and hydraulic power-producing plants, underground levels, and a hydraulic power distribution main, which power was not only to be used for working semi-portable deep pumps, but also to be made available for the actuating of surface-pumps situated in the low-lying areas. A large proportion of that part of the scheme which referred to the driving of the underground levels had been carried out. The commissioners were faced with the difficulty of either having to make an underground level from the pumps to every colliery in the district which was required to be worked, or to revert to the original state of affairs of having a pumping station in almost every colliery. This was altogether a position which it was impossible to contemplate either from an engineering or financial standpoint. Twenty-two tons of water were pumped in 1873 to 1 ton of coal or other mineral: and in 1898, notwithstanding the great reduction in the water, the commissioners' engines were pumping 24 tons of water to 1 of mineral, while if the water raised by pumping engines were added the proportion was 28½ tons. The only way to bring down the cost of working an increased number of stations within the range of the revenue was by some means not before available, to diminish the quantity of water that daily found its way to the mines from the surface. Having secured, through the Midland Electric Corporation for Power Distribution, the prospect of an early supply of electric energy at a cheap rate, the scheme for the extended drainage of the low lying portion of the surface became feasible. All the area of the Tipton district had been re-examined for suitable places for surface pumps, and 50 sites had been selected, and surveys made, for delivery channels to convey the water pumped to some existing watercourse. Although the quantity of surface water to be diverted from the mines was 3,000,000 gallons per day on the average, the pumps proposed should lift on emergency 25,000,000 gallons per day in storm time, when their help would be of the greatest advantage. The exact pattern of these pumps had not been settled; but now that centrifugal pumps were made to run at very great speeds, there should be no difficulty in obtaining a pump and motor of such simple construction, that it could be set at work by the throwing over of a lever when the water in the receptacle rose to the arranged height, and shut off when the receptacle was empty. These pumps would be required to raise water only to heights of 10, 15, or 20 feet, and it was impossible to over-estimate their value, especially in storm time, in preventing water from going down into the mines, to be lifted thence to heights of 400 or 600 feet. The water which travelled out of sight, frequently for great distances, between the level of the original surface of the country and the top of the artificial mounds which had been thrown up by the collieries and ironworks, would now be intercepted by the proposed electric pumps, and the drains connected with them, before it found places where it could get down into the mines. Water also flowed into the Tipton district from the high ground beyond the district boundaries. Where there were at present steam pumps, pumps worked by electricity would be substituted, and in consequence each place would produce greater effects than with the present steam pumps, as the electric pumps would be automatic, and might be all set to work simultaneously after a storm, instead of waiting, as with the steam pump, until the attendant could work them in turn. They might also continue at work night and day for some days together. The stations now used for periodical visits of portable pumps would also be fitted

with automatic electric motors and pumps and the swags near them would be kept permanently low instead of being visited only at considerable intervals of time, and thus the percolation of water into the mines would be more effectually prevented. Other stations would be placed where the old surface was still visible, between the pit mounds, or known to exist under the pit mounds, and to be reached by shallow pits, or where old pits now letting in the surface-water could be filled up to the place where the water entered, and an electric pump fixed at that level. There were old limestone quarries in the high ground south and west of the Tipton district, which were drained, when worked, by special engines or by waterworks engines now disused; and these quarries now formed funnels of large extent to catch the rainfall. Much of this water found its way through lower outlets into the mines. These would be most awkward places for steam pumps and for the formation of roads to them for the delivery of coal or other fuel, but comparatively easy and simple of access for electric pumps. Many clayholes existed, and also coal openworks for shallow seams and stone quarries, all of which formed collecting funnels for rainfall, and if, as was often the case, old pits existed in the bottom of them, these emptied themselves direct into the mines. Having given several other instances in which electrical power might be economically and advantageously used, the paper gave several other cases in which the electrical pumps would prove advantageous and economical, and concluded by emphasising the great gain to the mines and in economy of pumping by dealing at once with any water that could be dealt with at the surface. The near approach of electric power available for such a purpose seemed to offer a reasonable, safe, and ready help.

The chairman, Mr. G. Lewis, referring to some particulars that were given as to the cost of electricity, said that the paper was interesting not only with regard to the drainage question, but with regard to the possibility of having large generating stations in colliery districts from which power could be electrically transmitted to different collieries not only for pumping, but for general mining purposes. The price per unit quoted for the current, which was shortly, he understood, to be reduced to 1d., was an important point, seeing the price charged to ordinary consumers. Mr. Marten explained that the charge for the first hour was to be 3d. per unit, and ·825d. per unit afterwards. It was on account of the continuous use of the current that it could be supplied so economically. A vote of thanks was passed to Mr. Marten and Mr. Howell.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending Sept. 14th, 1897.	£	s.
Antwerp...	13	0
Bangkok	260	0
Beira	1,032	0
,, Teleg. mat. ...	40	0
Bombay	12	0
,, Teleph. mat.	24	0
Boulogne	11	0
Brisbane	50	0
Buenos Ayres	200	0
Calcutta	26	0
Cape Town. Teleg. mat.	1,890	0
Delagoa Bay	11	0
,, ,, Teleg. mat.	448	0
Durban	116	0
Flushing	74	0
Gibraltar	280	0
Gothenburg	7	0
Lisbon	94	0
Madras	19	0
Melbourne	50	0
,, Teleg. mat. ...	1,356	0
Odessa	750	0
Perth	191	0
Piræus. Teleg. mat. ...	124	0
Port Elizabeth	768	0
Rio Janeiro	325	0
Santos. Teleg. mat. ...	44	0
Shanghai	105	0
Singapore	7	0
Sydney	658	0
Wellington	7	0
Yokohama	30	0
Total	£8,932	0

Week Ending Sept. 14th, 1898.	£	s.
Adelaide	13	0
,, Teleg. mat.	134	0
Alexandria	16	0
Amsterdam	51	0
Boulogne	140	0
Calcutta	313	0
Cape Town	242	0
Colombo...	238	0
Copenhagen	140	0
Durban	943	0
Gothenburg	114	0
Hamburg	18	0
Helingsfors	27	0
Hong Kong	320	0
Madeira	124	0
Malaga	62	0
Melbourne	1,172	0
Ostend	8	0
Port Chalmers	14	0
Rio Janeiro. Teleg. mat.	375	0
Rosario. Teleg. mat. ...	154	0
St. Petersburg	160	0
Stockholm. Teleg. wire	105	0
Sydney	864	0
,, Teleg. cable ...	370	0
Tientsin Teleg. mat. ...	65	0
Wellington	882	0
Yokohama. Teleph. mat.	302	0
Total	£7,336	0

Foreign Goods Transhipped.

	£	s.
Adelaide. Teleg. mat.	39	0

Bankruptcy Proceedings.—Under the failure of J. Goodman & Co., gas and electric fittings dealers, 48, Commercial Street, E., the first meeting of creditors was held on Wednesday last, at the London Bankruptcy Court. The Chairman reported that accounts had been filed showing liabilities £3,850, and assets consisting of £4,000 £1 shares in J. Goodman & Co., Limited. It was a case of a German setting up business in this country, and upon getting into difficulties converting his business into a limited company with a nominal capital of £7,000. The company was not successfully floated, and the business had since been continued under the style of J. Goodman & Co., Limited. The debtor would now have to take the necessary steps to wind up the company and bring the business assets into his estate for the benefit of the creditors. Mr. Davis, on the debtor's behalf, said they would bury the company as expeditiously as possible, and be heartily glad to be rid of it. A resolution was passed for Mr. Benjamin Newstead, C.A., Church Passage, Guildhall, to act as trustee and administer the estate in bankruptcy.

Calcium Carbide.—It is reported that Messrs. Schuckert and Co., of Nuremburg, are about to establish large works in East Prussia for the manufacture of calcium carbide. It is proposed to use the water-power of the Passarge.

Change of Address.—The offices of the Cowper-Coles Galvanising Syndicate, Limited, will be removed on the 29th inst. from 39, Victoria Street, to Grosvenor Mansions, Victoria Street, S.W.

Como Electrical Exhibition.—The last date for the receipt of applications for space in the Electrical Exhibition, which is to be held at Como next year, has been extended to October 31st next.

Dissolution of Partnership.—Messrs. C. B. Hayes, H. M. Mitchell, and J. Wood (Mosses & Mitchell, vulcanised fibre merchants, 68—71, Chiswell Street, E.C.), have dissolved partnership so far as concerns Mr. Hayes. The two remaining partners will attend to debts, &c., and will continue the business under the old style.

Electric Wiring.—From Messrs. Perci & Schacherer, of VIII., Szigony-utcza 21, Buda-Pesth, we have received a price list of their patent flexible cords with interposed insulating rings for incandescent lighting. The conductors are made with small insulating rings, by means of which they are fixed in position, and there is no necessity to make any other preparation for their reception. A nail of suitable shape passed through the hole in the insulating ring holds the conductor to the wall. The insulating rings are 10 inches apart. The copper conductor is made up of a number of fine wires, stranded together. The insulating rings are made in three patterns:—No. 0, holding the cord directly against the wall (for dry situations); No. 3, double rings projecting $\frac{1}{4}$th inch behind the cord, and keeping it that distance from the wall; No. 5, keeping the cord $\frac{3}{16}$th inch from the wall. From the same firm we have received a card of samples showing a variety of colours of silk coverings for cords.

Explosions in Main Boxes.—During the past week there have been explosions in electric light main boxes at Edinburgh and Manchester.

First Meetings.—The first meetings of creditors and contributories in the case of the Cox-Thermo Electric Company, will be held at 11.30 a.m. and 12 noon respectively on September 22nd, at 33, Carey Street, W.C.

The General Electric Company.—On Thursday last week, September 8th, a party consisting of about 30 of the London staff of the General Electric Company, and about the same number of friends, spent a pleasant day inspecting the new supply buildings of the company at Victoria Bridge, Manchester, and their extensive works at Adelphi, Salford. By leaving Euston early the excursionists were able to spend a good five hours in Cottonopolis, dining being postponed till the return journey. The time at disposal was profitably spent. At 1 o'clock the new supply buildings were seen and admired, after which luncheon was served. At its conclusion the visitors were taken in brakes to the works at Salford, where many hours might have been spent without weariness watching the various processes which occupy the hands and heads of the thousand operatives here employed. But a hurried glance was all that time would admit of, and in the course of an hour or two the brakes were again in motion, this time on their way to London Road Station. To Mr. Hirst and Mr. Max Byng is due great credit for the perfect way in which the comfort of the party was studied and their entertainment provided for. It would have been hard indeed if their determination to make everyone enjoy the trip had not been fully realised, although one gentleman, by his own confession, was, when not asleep, looking over the hand of one of the "nap" players; in fact, having more than his fair share of nap without paying for it. The supply building at Victoria Bridge, which we understand is to be known as Electricity Buildings, was designed by Messrs. Waddington & Sons, architects, Manchester, and built by Messrs. Neill & Sons. It has been erected to meet the pressing requirement for a central depot to deal with increasing business in the Lancashire and Yorkshire districts, and no spot could have been better chosen, as it is within a minute's walk of both the Exchange and Victoria Stations. The owners claim that they are the largest premises devoted to a like purpose in the electrical trade. They are of striking and handsome elevation, and are being fitted up in a way worthy of the building. Every type of electrical apparatus will be exhibited under working conditions, especially motors, in illustration of their adaptability to domestic and industrial purposes. The building, which is six storeys high, has a frontage of 76 feet and a depth of 90 feet. The ground floor is alloted to the sales department, long counters running from front to back, and an office being provided for the head of each department. Over this there is a showroom for electroliers, brackets, glass ware and other goods of a decorative character. With the exception of a recess partitioned off and fitted up for the general manager's office this floor is undivided, and is the most extensive and best adapted to the purpose that we have seen. On the second floor are general offices and counting house, and on the upper floors, storerooms.

An interesting part of the building is the basement, where in addition to the packing department there is a large model room for illustrating the driving of tools, lathes, rock drills, and coal cutters by electric power. Here also is located a 50-H.P. high speed non-condensing compound engine (Sentinel) coupled to a two-pole dynamo of the company's make supplying current for working the passenger and goods lifts and for lighting the building. A handsome marble switchboard not only controls the distribution within the building, but enables the system when necessary to be switched on to the borough supply. The electric motors for working the lifts are of the company's well-known two-pole type. In a boiler house at the back is a boiler for supplying steam to the engine, and for generally heating the building. To the boiler is attached a Green's economiser, the scrapers of which are driven by a direct-coupled motor. Of the works at Salford we gave a description in our issue of October 16th, 1896, special reference being made to the variety of machine tools in use, and the extent to which they were worked by three-phase motors both direct and from shafting. Since that date the manufacturing branch of the company's business has become concentrated at these works, which are at the present moment being enlarged to a considerable extent to cope with the needs of the arc lamp and the telephone departments. In the meantime the various floors are rather crowded with workers. On one will be found row after row of girls, boys, and men at special tools stamping and shaping small parts, winding magnets, putting together bells, magnetos, telegraph and telephone instruments and similar work. On another is the work of a heavier nature, such as the building of marble switchboards, by electric power, three-phase motors driving all the tools employed. The instrument making department proved interesting on the occasion of the visit, owing to there being in course of construction some of the new form of ammeter and voltmeter, the peculiar feature being that they are sunk in the switchboard with their face flush with the surface. A novel form of combination instrument was also in hand for testing voltage current and insulation. The wood-working, tool making, and dynamo construction occupy larger areas, but room is found for all necessary operations on the premises even for such as silver plating and gilding.

The Forthcoming Educational Session.—We have already referred to several announcements made by various colleges and technical institutions. We now understand that the evening classes at the East London Technical College, People's Palace, in electrical engineering, including lectures and laboratory work by Mr. J. T. Morriss, will commence on September 27th. The new session of the Northern Polytechnic Institute, Holloway Road, N., begins on September 19th. The department of physics and electrical engineering is under Mr. V. A. Mundella, B.A., B.Sc. There is to be lecture and laboratory work in general physics, electricity, electrical engineering, electric wiring and house-fitting, &c. Secretary, Mr. E. Griffiths. See our "Official Notices" this week for particulars.

We have before us the announcements of classes and other proceedings in connection with that very excellent institute, the Northampton Institute, St. John Street Road. The splendidly equipped laboratories, workshops, and class rooms cannot fail to attract many who are in pursuit of knowledge, technical and otherwise. We gave a brief description of them in the Electrical Review for March 25th, on the occasion of the formal opening by the Lord Mayor. The electrical engineering and applied physics department is under the control of Dr. R. Mullineux Walmsley, the principal of the Institute; his chief assistant and senior lecturer is Mr. C. V. Drysdale. Instruction is to be given in magnetism and electricity, electrical instruments, applied electricity, telegraphy and telephony, the latter section being under the lectureship of Dr. Walmsley, with Mr. W. H. Winny for laboratory work. There will be lectures in applied electricity for telegraphists and telephonists, electrical and telegraphic instrument making. In the electro-chemistry branch, Mr. Samuel Field is lecturer and demonstrator; he is also in charge of the electro-plating sections. We must refer our readers and intending students to the illustrated syllabus, which gives everything in a very detailed manner.

The evening department of the Polytechnic School of Engineering, 307-311, Regent Street, W., commences its winter session for courses of instruction in engineering and mechanical science on Monday, September 26th. Particulars from the director, Mr. Henry Spooner.

The Gilbert Arc Lamp Company.—This company have arranged a large contract for lighting the new buildings which Messrs. Lyons are erecting in Draper's Gardens, E.C. The work is being carried out almost entirely by electric light night and day, and the building commences with a basement 40 feet below the ground. The company have just completely fitted St. Andrew's School, Southboro', and St. Andrew's School, Eastbourne, and are also carrying out the lighting of the New Kensington Town Hall, where the wiring is being entirely fitted in iron pipes. They are just delivering to the Blackpool Corporation their order of 120 double carbon rectified arc lamps and apparatus. These lamps are of the firm's open type, burning 50 to 80 hours according to current density.

Lists.—Messrs. Redpath, Brown & Co., Limited, of St. Andrew Steel Works, Edinburgh, have issued a list of the "Stirling" water-tube boiler, giving illustrations and explaining its advantages.

Mr. A. J. Wright, of 318, Upper Street, N., sends us his trade price list of electric bells, indicators, wires, batteries and accessories.

The Electrical Company, of Charing Cross Road, has published a new list of direct current dynamos and motors. It embraces new types and a wider range of machines than in previous lists, and improvements in all. The sheets abound in illustrations, sectional drawings and photographic views of the various machines, and there is considerable tabulated and descriptive matter, also prices in many cases. The list will be useful to the trade.

We have received from Messrs. D. H. Bonella & Son, of 58, Mortimer Street, W., a price list of high voltage lamps. This firm is making a specialité of fancy twisted flame and small bulb lamps for burning direct on high voltage circuits and also in series.

Messrs. P. R. Jackson & Co.—This firm has a very large number of important orders in hand, and has also a very large stock of dynamos.

New Business.—The District Electric Company has commenced business at 34, Livery Street, Birmingham, for the installation of electric light, telephone, bell and other systems. Mr. L. Stallybrass, who we understand has had considerable experience in these lines both in England and America, will watch over orders.

A New Phase in Alternating Currents.—While looking over the Langdon-Davies Alternate Current Electric Motor Company's works the other day, we saw a new form of single-phase motor. From what we saw it would appear to us that it is destined to remove the objection, at present hanging over the single-phase system, of not being suitable for lifts and tramcars, as it had a starting torque about 12 times as great as that of their ordinary motor for the same current, and its speed can be regulated at will. Alternate current supply companies would do well to await the course of events before altering any part of their plant to two-phase or polyphase working.

Smoke Nuisance.—Last week, before Mr. Lushington, the National Liberal Club, the Charing Cross and Strand Electric Supply Corporation, and the Tivoli Restaurant, Limited, were summond by Mr. G. W. Murnane, clerk to St. Martin's Vestry, for causing a nuisance by allowing large quantities of black smoke to escape from their works. For the Charing Cross Electric Supply Corporation Mr. George Elliott said that since they had been served with the summons they had used every endeavour to mitigate the nuisance, and with the exception of two days there had been no possible cause for complaint. He would guarantee that so long as they could get good hard steam coal, whether Welsh coal or not, there would be no further nuisance. Mr. Lushington said that in this case, as the company seemed to have succeeded in reducing the nuisance, he should make no order. The summons against the Tivoli Restaurant was by leave withdrawn. Mr. Lushington made an order for abatement at the National Liberal Club, with £5 5s. costs to the Vestry.

To Creditors.—Persons having claims against Samuel Scargill and Albert Hanson (trading as Scargill and Hanson, electrical engineers, 10, Booth Street, Bradford), should send (by October 8th) particulars to Mr. G. W. Smith, 23, Bank Street, Bradford, trustee under a deed of assignment dated June 30th, 1898. A first and final dividend is about to be declared.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The Gas and Electric Lighting Committee recommends the extension of electric mains to Rubislaw Den North (cost, £168). It has authorised the electrical engineer to prepare a specification for lighting the Art Gallery by electricity.

Barrow-in-Furness.—The County Council, by 19 votes to 9, has referred back to the Highways and Lighting Committee a minute *re* the lighting of the streets of the town. The committee had determined not to adopt electricity for street lighting at present, but since then the Electric Light Committee has met and decided to offer to supply energy for the 21 arc lamps proposed to be erected at £15 per annum, instead of £17 10s. as previously offered. So the matter will be again considered. A site has been purchased in Abbey Road for a transformer sub-station.

At a meeting of the Lighting Committee on Wednesday afternoon, it was determined to light a few of the principal streets with electricity as an experiment.

Bath.—Last week the Electric Light Committee held a meeting to discuss the long delay in completing the installation of new plant and machinery at the works. Mr. May, representing Mr. Hammond, the consulting engineer, said the contractors were entirely to blame. Mr. Tonkin said he had understood these new works were to have been finished last winter. The chairman said he could see no ending to the work at present. A resolution was adopted referring the matter to the Works Committee for immediate consideration, and calling upon Mr. Hammond for a special report. Mr. Metzger had presented a long report upon the machinery necessary to complete the work, and stated that he thought with ordinary success the condensing plant might be working in thorough order in from seven to eight weeks. The delay arose, he considered, from the parts not arriving fast enough.

Battersea.—The Finance and Law Committee reported to the Vestry on Wednesday evening that the County of London and Brush Provincial Electric Lighting Company had applied to the court for a further suspension of the injunction granted against the company in regard to the laying of electric light mains in Trinity Road. The Vestry opposed the application, but before the case was brought into court the company informed the Vestry that the pipes laid in Boundaries Road, and upon which question the surveyor had sworn an affidavit, had been removed. Mr. Justice Stirling, before whom

the application was heard, decided to further suspend the injunction, but ordered the company to pay all the costs in connection with the matter.

Bedford.—The Council will join with other municipal authorities in resisting the claims of Mr. Martin Rucker.

Bloemfontein.—The Town Council has passed a scheme to light the town with electricity, and has accepted Messrs. Reunert and Sons' tender for £16,500.

Bournemouth.—The Electric Supply Company intend making substantial reductions in their charges for current from January 1st next.

Bradford.—The accounts of the electricity department for the half-year ended June 30th, showed that the total income for that period was £9,565, an increase of £839. The profit for the half-year was £1,658 10s. 2d., against £1,665 10s. 2d. The number of consumers was 720, against 521, an increase of 38 per cent. The trade profit for the half-year was £3 4s. 9½d. per cent., and the net profit, after charging interest on sinking fund, 18s. 7d. per cent.

The Gas and Electricity Supply Committee propose to borrow £10,000 for the extension of electric cables within the city.

Brierley Hill.—The Lighting Committee has reported that the Dudley and Stourbridge Electrical Energy Company applied for the Council's consent to a provisional order to supply electrical energy within the district. The committee had adjourned the matter for further consideration. The Council has approved of the plans of the British Electric Traction Company for the posts to be erected for the electric tramways.

Brighton.—Notice has been given, on behalf of Mr. Martin B. Rucker, that the Brighton Corporation are infringing patents held by him for improvements in distributing electricity. The town clerk has informed the Lighting Committee that he and Mr. Wright, the engineer to the Corporation, attended a meeting convened by the London Electric Supply Corporation, and that Mr. Wright also attended a meeting of the Municipal Electrical Association. Both meetings were attended by representatives of municipal corporations, local authorities, and others interested, and at these it was decided to take combined action to resist the claim.

Bolton.—Mr. George Swainson, treasurer for the Bolton Corporation, has just issued his "Blue Book," dealing with the finances of the several departments owned and managed by the Corporation. He reports that the Electricity Committee have now for the first year turned the corner which divided profit from loss. In 1895, there was a loss on the working by £591, which was charged against the rates; in 1896, the amount was increased to £1,054; but in 1897, it fell to £269. During the last financial year a profit of £917 was earned and carried to the reserve fund. The capital account has grown from £24,459 in 1895, to £57,037 in 1898, a sum which will be largely augmented when the Corporation generates electricity for the working of the trams. In 1895, the Board of Trade units generated totalled 45,968, and last year the figures stood at 480,836. During the same period the cable had been increased from 9,000 yards to 34,750. The current supplied to customers yielded this last year £5,720, as against £3,736 in the proceeding twelve months.

At last week's Council meeting a discussion took place in reference to the purchase of land by the Electricity Committee for the extension of the works in Spa Road. The extension has been rendered necessary in view of the proposal to run the trams by electricity, and for the purpose of laying down the necessary plant to supply the areas recently added to the borough, borrowing powers for this purpose having been acquired to the extent of £250,000.

Buckley.—The Urban Council has passed a resolution to obtain a provisional order for lighting the district by electricity, and has resolved to engage the services of an electrical engineer. Tenders for electric lighting had been received from the Sandycroft Engineering Company and Messrs. Mather & Platt.

Canterbury.—The contract for the electric lighting of the Foresters' Hall, the largest public hall in the city, has been placed in the hands of Mr. E. J. Philpot.

Carlisle.—Workmen are at present busily engaged in laying cables in the streets, and in a few weeks it is hoped that the city will be lighted with electricity. The Corporation have decided that the charge at the outset shall be 5d. per unit. The price of gas is 2s. 3d. per 1,000 cubic feet.

Castletown.—The Town Commissioners have given permission to Messrs. Mylchreest & Co. to carry a wire over the streets from the barracks to their premises in Malew Street, for lighting them by electricity.

Cheltenham.—The Council will join with the London Electric Supply Corporation and others in resisting the claim made by Mr. Martin Rucker in regard to the Zipernowski transformer patents. It has been decided in lieu of the sums of £875 and £3,000, for which it was resolved at the meetings of this committee, held on May 26th and June 23rd last respectively, to apply to the Local Government Board for sanction to borrow, to apply for sanction to borrow the sum of £9,000 to provide for the items of expenditure specified in the report of the electrical engineer, which includes the items for which the said sums of £875 and £3,000 were required, and £2,500 for the necessary alterations and additions to the central station as estimated by the borough surveyor.

Cork.—The electric lighting question was discussed by the governors of the Cork District Lunatic Asylum last week. It had previously been decided not to adopt electric lighting, but last week the governors, by 11 votes to 9, rescinded the previous resolution, decided to further consider electric lighting, and referred the matter to a committee of the whole board.

Coventry.—The Electric Lighting Committee has reported that legal proceedings have been threatened with respect to patent rights affecting the alternating current system of electrical supply. The committee will join in with other Corporations in defending the action, and pay a proportionate share of the costs.

Denton.—The Tramways Committee have received a letter from the Ashton-under-Lyne Corporation asking if, in the event of their deciding to promote a Bill in Parliament authorising them to supply electricity outside the borough, the Denton Council would at the same time apply for the usual provisional order under the Electric Lighting Act, and, on the necessary powers being obtained, if they would be willing to enter into an agreement for being supplied with electricity by the Ashton Corporation. The clerk was instructed to communicate with the Ashton Corporation as to their terms, and also with the Levenshulme Council with regard to the report recently made to them on the question of lighting their district by electricity. A letter was read from the Board of Trade stating that they had extended the time for the completion of the Oldham, Ashton, and Hyde electric tramways to February 12th, 1899, and that the company had made out a case for a "single decker" car. It was resolved that, whilst having no further observation to offer on the subject, the Committee were of opinion that cars with outside seats were best adapted for the requirements of the district, and the clerk was instructed to ask the Hyde Corporation, the Ashton Corporation, and the Audenshaw District Council what action they were taking.

Derby.—The Electric Lighting Committee of the Derby Corporation reduced the applications (62 in number) for the post of borough electrical engineer and manager to three, and on Wednesday the names were submitted to the Council. Mr. T. P. Wilmshurst, chief of the Halifax Corporation's electric works, was then appointed electrical engineer and manager of the Derby electric light works. The appointment is worth £350 a year, with the privilege of taking two pupils. The principal points in Mr. Wilmshurst's favour were that the same system of electric lighting is in vogue in Derby as in Halifax, and that he had laid down the electric tramway there. This work is contemplated in Derby. Moreover, Mr. Wilmshurst stated that his sole reason for wanting to leave Halifax was because it was not exactly a Paradise to live in. Mr. Wilmshurst secured 52 votes out of 55, the numbers of members present.

Dewsbury.—The Town Council on Tuesday last week had before it the following resolutions of the Gas and Electricity Committee:—1. That for the purpose of relieving the present overloaded condition of the existing feeding mains and distributors, the principle of increasing the voltage from 220 volts to 440 volts be adopted in preference to that of duplicating the mains, the estimated cost of such increase being £2,232 2s. 2. That the extension of the mains into Oxford Road, West Park Street, James Street, and Park Road be proceeded with, and that the electrical engineer do obtain tenders for the supply of the necessary cable, and the laying down of the same. 3. That the town clerk do give the necessary notices to owners of premises fronting, adjoining, or abutting upon the said streets of the intention of the Corporation to carry out such works.

Dundee.—Messrs. Thomas Justice & Sons, Limited, recently asked a Committee for a supply of electric current on the best terms possible. The supply required would be for at least 500 16-C.P. lights, to light up their workshop in South Ward Road. After discussion the Committee agreed to recommend that the price should be as follows:—Up to and including 10,000 units per annum, 4d. per unit (the present rate), and above 10,000 units, 3d. per unit, to all consumers.

Edinburgh.—The Electric Lighting Committee last week gave further consideration to their estimates for the current financial year. The result of their deliberations was that in consequence of the greatly increased private demands for the light, they placed their estimate of revenue for the year at £54,000 instead of £51,000. It was further understood that of the expected £3,000 of increased revenue £1,000 should be placed to reserve, and £2,000 transferred to the burgh assessment account for the relief of the rates. The committee also decided that the minimum charge for the private consumption of the light should be £1 per annum instead of 13s. 4d. per quarter, as heretofore.

Elland.—About half of the members of the District Council went to Nelson last week to inspect the electric lighting arrangements there.

Hampstead.—Messrs. H. G. Ellis & Co., Limited, of Victoria Street, state that they have secured the contract (by tender) for the electric installation and fittings for the Hampstead Workhouse.

Hartlepool.—The surveyor has been authorised to prepare plans in connection with the proposals to light the borough by electricity.

Haslingden.—The Town Council on 8th inst. resolved to apply for a provisional order for electric lighting.

Heywood.—The Town Council has instructed the manager of the sewage works to obtain an estimate for the electric lighting of those works, and also of the Infectious Diseases Hospital.

Hull.—The new electric light station in Sculcoates Lane has been completed, and the new plant is running. It is anticipated that by the end of the year it will be working to its full capacity, so great is the demand for current.

King's Lynn.—On 7th inst. Mr. Sandford Fawcett, A.M.I.C.E., held a Local Government Board inquiry *re* the Town Council's application for power to borrow £30,000 for electric lighting purposes. Particulars *re* provisional order, &c., were given by the town clerk, and Prof. Robinson, who is acting as consulting engineer, explained that he had been authorised to obtain tenders and make plans, &c., for the various works. The Mayor and other members of the Council attended to support the scheme, but Alderman Pridgeon opposed on the ground that the ratepayers did not want the installation. He thought it curious to advertise for tenders, &c., before the Local Government Board had given its sanction.

Kirkcaldy.—The Town Council has now resolved to apply to the Board of Trade for a provisional order to introduce the electric light into Kirkcaldy. This is in opposition to the application of the Edmundson Electric Lighting Corporation, London, who have also given notice of their attention for applying for such an order. The town authorities have further agreed to apply also for a Parliamentary Bill or provisional order to introduce electric tramways. The position of the Kirkcaldy Corporation is, that while they do not intend to take up the schemes personally, they wish to have the powers to promote both schemes, and hand them over to the company offering the best terms, although there is a distinct feeling in favour of the promoters of the local company who offered to complete the scheme having the preference.

Llandudno.—At a special Council meeting last week, the seal of the Council was affixed to a loan of £1,564 towards electric lighting purposes. The sum is to be repaid in 24 years at 2¾ per cent. interest.

Mauritius.—We are informed that the contract for electric lighting for Port Louis, Mauritius, has been placed with the Birmingham Installation Company. Mr. F. J. Warden-Stevens is consulting engineer for the work. The estimated outlay is £75,000.

Monmouth.—At the last week's Council meeting a lengthy debate arose on the presentation of a report by the Drainage and Electric Lighting Committee. The report dealt with sewage matters, and the question of site for sewage works. Another matter that arose was regarding an electric transforming station. The town clerk reported that Messrs. Siemens Bros. & Co., the electrical contractors, wanted a site for one of the transforming sub-stations, and the old police station was approved by the Council as suitable.

Newcastle.—The Town Council held a special meeting last week, at which it was decided to apply for a provisional electric lighting order for supplying the district of the municipal borough. A committee was appointed to follow the matter through.

Newport.—In a recent report to the Electricity Committee, the office manager showed that the number of lights now connected and on order is equivalent to 19,164 8-C.P. lamps. As the result of a month's canvass, orders for 337 lights were obtained. In consequence of the large number of orders for the light, an additional jointer's kit is to be purchased, and an additional jointer appointed. The borough electrical engineer's report upon the condition of the plant was read, from which it appeared that the condenser had developed some defect, and that one of the converters in the sub-station at the Town Hall had failed. These matters were being taken up by the contractors. A comparison of the plant, with the number of lights connected, was also given. The Council will join with the London Electric Supply Corporation in contesting the claims of Mr. Martin Rucker *re* the Zipernowski patents. A report by the consulting engineer upon arc lamps was read, from which it appeared that seven or eight different kinds of lamps had been tested, with the result that he recommended that the tender of the Electric Construction Company, Limited, for the supply of 34 arc lamps, for the sum of £708 10s., be accepted. It was resolved that the tender of the Electric Construction Company, Ltd, be accepted.

North London.—The North London Electricity Company's proposal to apply to Parliament next session for a provisional order to enable them to supply electricity to various North London areas, is causing a good deal of activity on the part of the authorities whose districts are concerned. The Finchley Council, taking the lead in the matter, have convened a conference to discuss the matter, and have invited the District Councils of Barnet, East Barnet, Friern Barnet, Hendon, Hendon urban, Hendon rural, Hornsey, Wood Green, Enfield, Edmonton, Tottenham, and Southgate to send delegates. The Barnet Council, who hold a provisional order of their own—although for some years past it has been a sort of "white elephant"—have decided not to attend the conference. It is not to be implied from this attitude, however, that they will consent to the order being granted to a private company.

The East Barnet Urban District Council appointed two representatives to attend a meeting at the Guildhall, Westminster, on September 13th, to consider the proposal of the North London Electricity Company to apply to Parliament for a provisional order authorising them to supply electricity throughout an extensive district, including Finchley and Barnet.

The Enfield Urban Council has also been discussing the same company's proposals, which, we understand, apply to the Finchley district, together with the districts of Southgate, Edmonton, Enfield, Tottenham, Hendon Urban, Hendon Rural, Hornsey, Wood Green, Barnet, Friern Barnet, East Barnet, Chipping Barnet, and New Barnet. The Council has referred the matter to a Committee.

Northwich.—It is stated that the Northwich Electric Supply Company have taken over the house wiring business of Messrs. Ames, Garrard & Co. in Northwich, which they intend carrying on under the management of Mr. F. W. Ames, whom they have also appointed as their resident electrical engineer in place of Mr. F. Kenyon.

Nuneaton.—It is stated that the demand for electric current is so great that the company is doubling the capacity of its plant.

Oldham District.—The Mossley Town Council do not seem to be in favour of adopting the electric light. The Ashton authorities have made overtures to them, stating that the Corporation would shortly be in a position to apply electrical energy in the borough on terms to be agreed upon. The result of the deliberations was that no action was taken in the matter. One of their objections perhaps lies in the fact that they have a gas undertaking of their own. Some trouble is being caused by the chimney of the electric light works of the Oldham Corporation emitting an undue quantity of black smoke. The Sanitary Committee have ordered the Electric Light Committee to desist, but this committee say they are doing their best to that end. The town clerk said it might seem foolish to summon another committee, but it was the only course open to deal with them, as they did private firms.

Perth, West Australia.—Under the supervision of Mr. Dawson, the electrical engineer for railways, the electric light has now been successfully installed at the Perth Railway Station. The installation consists of 26 arc lamps and 250 incandescent lamps, the latter being intended for use in the various station buildings. The generating plant is accommodated in a building which has been erected in Wellington Street, and it includes a half-dozen dynamos manufactured by Messrs. J. H. Holmes & Co., of Newcastle-on-Tyne. These are placed in the upper portion of the building, the boilers being situated below. The full plant has not yet been set going. Only two of the dynamos were running when the current was turned on at the beginning of August. The electric light was installed at the Fremantle station in the beginning of the year, and the work of installing the light at the Perth Railway Station has been carried out at a cost of about £11,500.

Petersfield.—There is a strong agitation going on against the introduction of the electric light into Petersfield, as contemplated by the Urban District Council. A petition of the ratepayers was brought to the meeting of the Council on the 8th inst. by a deputation; but as no notice whatever had been given to the Council, the chairman declined to receive it, saying he considered the promoters were not treating the Council courteously in coming in that manner, and, moreover, when the Council had finished all the business on its agenda, and the Council ought to stand on its dignity. The deputation consequently retired without achieving their purpose. The chairman's action has met with very general approval in the town. The great debate on the electric light scheme will come on at the next meeting of the Council on the 22nd inst.

Salford.—At the last meeting of the Corporation the common seal of the Council was attached to a contract with the British Insulated Wire Company, Limited, for the supply of 1,000 yards of ·062 high tension, lead covered concentric cable for the electric light works.

Solihull.—The Rural District Council has refused to consent to the proposed application of the Birmingham Installation Company to the Board of Trade for a provisional order authorising the company to supply electricity.

St. Pancras.—The Electricity and Public Lighting Committee reported to the Vestry at the last meeting that in view of the extensions of the buildings in course of progress at the Regent's Park station not being sufficiently advanced to enable the additional plant on order being fixed and in working order to meet the coming winter's demand, they had had to consider the question of hiring some temporary plant to tide over the difficulty. The matter being of extreme urgency, the Vestry decided to empower the Committee to take such measures as might be necessary to cope with the demand. On the recommendation of the Committee it was decided in future to charge consumers requiring a combined day and night supply on the maximum demand indicator system. The Refuse Destructor Committee announced having given permission for the temporary use of a portion of the destructor yard for the purpose of accommodating plant ordered for the Stanhope Street station so as to aid that station in dealing with the additional load during the winter months.

Stafford.—The Council has increased the salary of the chief assistant in the electricity department from £125 to £150 per annum. The Gas and Electricity Committee has made satisfactory arrangements for a 12 months' supply of coal. Last week, at the Council meeting, it was stated by Mr. Westhead that the increase of electricity sold during the quarter ended June 30th amounted to no less than 38 per cent., and the consumption for the last four weeks showed an increase of nearly 21 per cent, so it would be seen that the sale of electricity was increasing rapidly.

Stalybridge.—The Town Council is not willing to join with the Ashton Corporation in its application for electric lighting powers upon the lines suggested. Neither will the Council approve of the proposed application for powers by the Electric Power Dis-

tribution Company. It is held that if the town has an electric lighting installation the Stalybridge Council should be the undertaker, as it is already the owner of the gas works.

Stretford.—By the casting vote of the chairman the District Council last week decided to carry out the provisions of its electric lighting order of 1897, and to appoint a resident engineer at £300 per annum. A sub-committee will visit any districts necessary to obtain information.

Stockton.—The Local Government Board has sanctioned the borrowing of £28,482 for a period of 25 years, for the purposes of erecting works in connection with the electric lighting scheme adopted two months ago.

Teignmouth.—The surveyor is to prepare particulars for the District Council preparatory to the application for a provisional order for electric lighting. The gas works are in the hands of the Council, and it is considered that if electricity is introduced it must be kept in the Council's hands, so that a company is not allowed to compete with the municipal gas supply. This hardly seems to be the right spirit in which to embark upon an electrical scheme. The discussion seems to indicate that when both gas and electricity are worked by the municipality that one will not have its share of attention. As it is, the gas works are stated to be in "a bankrupt state." But the Council's present move is made merely to keep companies clear of the ground. If its idea is to let its provisional order lie on the table, so to speak, we hope that private enterprise will defeat that object.

Trowbridge.—At a meeting of the Council last week the question of applying for a provisional order for electric lighting purposes in the urban district was considered; but while it was unanimously agreed that no monopoly should be given to a private company in this respect, it was felt that the question was hardly ripe for such action being taken at present.

Wallingford.—The Town Council recently offered to buy the gas undertaking for £7,500, but the company has refused. There was some talk at the last meeting of electric lighting, one speaker remarking that its introduction would be the making of Wallingford. From remarks made, it would appear that a company might stand a chance of being allowed to introduce an electric lighting installation here.

West Ham.—It is expected that the electricity works will be ready for public supply by September 29th.

Weston-super-Mare.—A special meeting of the Urban District Council was held on 8th inst. to consider the following motion: "That all resolutions passed by the Council for the carrying out of their electric light provisional order, and such other resolutions as may be opposed to the transfer or lease by the Council of their powers under the said order to a company or other persons be, and are hereby, rescinded." After the whole of the members had spoken a division was taken, with the result that the voting was equal—nine to nine. The chairman gave his casting vote against the motion to rescind, and it was therefore lost.

The District Council has resolved by 10 votes to 7 to utilise land adjacent to the statutory hospital as the site of a generating station. When the approval of the Local Government Board is obtained, the clerk will instruct Mr. Hawtayne, the electrical engineer, to prepare plans and specifications and detailed estimates, and forward the same to the Local Government Board, together with an application for a loan to carry the scheme to completion.

Whitstable.—The Urban Council decided last week to apply "at the proper time" for a provisional order for electrically lighting the district, and when such order has been obtained to "proceed in the best and most economical way to procure the plant for generating and distributing electricity as soon as the district is ripe for its reception."

Wolverhampton.—At the meeting of the Town Council on 12th inst. the Lighting Committee reported that they had had under consideration a scheme for the extension of the electrical undertaking, involving a large capital expenditure, which it is proposed to submit to the Council in October. The scheme provides for the extension of the generating and distributing plant at an estimated capital cost of £29,000, which should meet all demands likely to be received in the winter 1899-1900. The Committee recommended that machinery costing £3,200 be obtained at once, this plant to form part of the scheme previously referred to. The Committee further asked that the Finance Committee be authorised to apply to the Local Government Board for their sanction to a loan for the purchase of the plant.

Worcester.—At a recent City Council meeting, in reply to Mr. Parker, Mr. Millington stated that the arrangements with the Electrical Free Wiring Company had worked very satisfactorily, and 16 premises had been wired under the system. They had as many customers as they could take, but they hoped shortly to be in a position to take a great many more.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Another Proposed Underground Electric.—Suburban London on the north-west is to have an electric underground railway into town, if the powers are propitious. A Bill will, according to the *Financial News*, be introduced next session to obtain the right of constructing a railway from Cricklewood, through Kilburn and under Hyde Park, to Victoria. This is a district which has been developing very rapidly of late years, and is still capable of considerable expansion. But not only would the district benefit by the new enterprise; such a railway would greatly relieve the traffic along the Edgware Road and Park Lane. Vested interests may be expected to oppose.

Baker Street and Waterloo Railway.—We learn from an exchange that preparation for work on this railway, which is to be worked electrically, is being rapidly pushed forward by the contractors, Messrs. Perry & Co. The large staging in the Thames by the side of the South Eastern Railway Bridge at Charing Cross is now approaching completion. The line when completed will be three miles and one furlong in length, and will connect the station at Baker Street with the Waterloo Station. The route will be as follows:—From under the Thames near the above bridge, up Northumberland Avenue to Trafalgar Square, Haymarket, Piccadilly Circus, Regent Street, Great Portland Street to Baker Street. Stations will provide connections with the Metropolitan and District Railway at Charing Cross and Baker Street, and with the Central London Railway at Oxford Circus. The Great Central Railway will also be connected at Baker Street. The engineers for the line are Sir Benjamin Baker and Messrs. Galbraith and Church.

Blackpool.—At last week's Town Council meeting, Mr. Brodie moved the adoption of the Electric Lighting and Tramway Committee's minutes, and called the attention of the Council to two resolutions accepting tenders for combined electric lighting and tramway traction posts for tramway cables in connection with the overhead trolley system. These two tenders, he said, bound the Council to the overhead system. They had discussed the question last year, when the proposal encountered strong opposition, and the matter had been sanctioned by the Local Government Board, which had given them borrowing powers. A strong argument against the scheme had been the fact that the Promenade had not been widened, but they were told by Mr. Quin, the engineer, that the town would save £1,500, while when the Promenade was widened it would only take £500 to remove the posts. Mr. Brodie also mentioned that the penny fares had been such a success that they had decided to recommence them on October 1st; the penny fares would then obtain until June next, with the exception of Easter and Whit weeks. The minutes were adopted.

Colywn Bay.—At a special meeting of the Urban District Council last week, the clerk submitted a draft of the provisional order about to be granted by the Board of Trade, to the promoters of the light railway between Colwyn Bay and Llandudno. The Council's barrister reported that all the clauses were satisfactory and in conformity with the arrangement come to with the syndicate, with the exception of that referring to the supply of electricity, which required slight alteration. The Council appointed a small committee to see that the clause was put right.

The Light Railway Commissioners have intimated their intention to sanction the construction of the railway.

Coventry.—At Tuesday's Council meeting, having regard to the proposal of the Coventry Electric Tramways Company to alter the existing lines in the city, and to effect other improvements in their system, the General Works Committee recommended that Cross Cheaping and the Burges be paved with granite setts, the estimated cost being £1,000. The committee also resolved that in all future extensions of telephone wires within the city the same be required to be placed underground. The recommendation was adopted.

Dover.—At the Town Council meeting on Tuesday, it was officially reported that the first year's working of the Corporation electric tramways, after allowing for payment of interest and instalments of the loans, had resulted in a profit of £1,300 being earned. This is equivalent to a 2d. rate. A total of 1,794,903 persons have been carried at the universal fare of 1d.

Dublin.—On 6th inst. the electric tram service from Nelson's Pillar to Dalkey was inaugurated.

Dundee.—A conference took place in the Town Hall, Dundee, on 8th inst., between the promoters of the Dundee and Broughty Ferry light railway and the Tramways Committee of Dundee Town Council, for the purpose of discussing the scheme. With regard to Railway No. 1—from the High Street of Dundee to the burgh boundary at Craigie Terrace—it was practically arranged that the promoters should abandon that portion of their undertaking, on the understanding that a Tramways Act was promoted by the Town Council giving them power to construct a line of their own from High Street to the burgh boundary to meet Railway No. 2. As regarded Railway No. 2—the line from the burgh boundary to Barnhill—it was indicated that the Council were prepared to give their support to it, provided a satisfactory running arrangement were entered into, and in the meantime it was arranged that an agreement should be drafted embodying the terms. Various matters were discussed.

Exeter.—The syndicate which runs the Exeter horse tramways applied to the Council of that city, on Wednesday, for their consent to the trams being propelled by electric traction on the overhead trolley system. The Corporation manufacture their own electricity, and the syndicate will in all probability obtain its power from the city generating station, should the Council eventually grant the application.

Dewsbury.—The General Purposes Committee recently recommended that the application of the British Electric Traction Company to Parliament for power to construct and run tramways should be opposed, and that the borough electrical engineer should report upon a scheme of tramways in connection with the local electricity works. This was agreed to by the Town Council.

Gateshead.—The City Council last week considered a report by the Parliamentary Committee on the tramway question. The Committee reported that they had considered the question whether the tramways of the borough should, in the future, remain in the hands of a company, or be taken over and worked by the Corporation. The Committee, so far, did not see their way to express an opinion on the important question, and recommended before any decision was come to on the application of the Gateshead and District Tramways Company—to postpone the exercise of their powers to purchase the tramway undertaking for a further period of 21 years—that the Council should obtain expert evidence as to the probable cost of construction and equipment of tramways in the borough on the overhead electric wire system, including an estimate of the probable cost of purchase by the Corporation of the existing tramway undertaking at the expiration of the current period of 21 years from the date when the promoters of the tramways were empowered to construct the same. The Committee also recommended that expert evidence should be obtained as to the advantages (if any) which would be derived from working electric tramways and electric lighting from one central station. The Committee had decided to recommend the employment of Dr. John Hopkinson to make the report, but after hearing of his sad death they advised the Council to engage *Prof. Henry Robinson, engineer to the Imperial Tramways Company.* We do not know whether the italicised words are as they appear in the minutes, but printed as they are in this way in the *Newcastle Leader* they are incorrect. Mr. J. Clifton Robinson is the Imperial Tramways Company's engineer. In the course of discussion Ald. Armour urged that the municipalisation of the tramways would be a very serious barrier to extensions to the outlying districts. He moved that the report of the Parliamentary Committee relative to the tramways be not adopted, but in lieu thereof that the offer of the company be accepted, subject to the company agreeing to half-penny fares in the townward portion of their proposed lines. Mr. Walter Willson seconded the motion, and spoke against municipalisation. After further discussion Ald. Armour's motion was made to read as follows:—"That the recommendation of the Parliamentary Committee relative to the tramways be not adopted, but in lieu thereof that the offer of the company be accepted subject to their agreeing to the same clause as is inserted in the Stockton Tramway Company's Order, empowering the Corporation to purchase at the end of seven or 14 years, and also agreeing to half-penny fares in the townwards portions of their proposed lines; and that it be an instruction to the town clerk and the Parliamentary agents to prepare an agreement providing for this and otherwise safeguarding the interests of the borough." In this form it was carried by 18 votes to 11. As amended the report was then adopted.

Great Yarmouth.—Acting on the advice of Mr. W. H. Preece, the Town Council resolved on Tuesday to retain their monopoly to supply electrical energy to Gorleston and Southtown, a district of some 14,000 inhabitants, and instructed their surveyor to bring up a report on the question of extending electric lighting to that part of the borough. A communication suggesting that the British Thomson-Houston Company should lay down and work electric tramways in both Yarmouth and Gorleston, taking power from the Corporation, and together with the question whether the Corporation should proceed with a tramway scheme, was referred to committee. In the course of a discussion, Mr. F. Arnold stated that for the first time the public had no deficiency to meet in connection with the Corporation's electric lighting undertaking. On the contrary, there was a net surplus of £200 this year, and he anticipated that much greater profit would be made.

Grimsby.—The work of relaying the tramway lines has been commenced by the contractor, Mr. C. S. Duke, of Plymouth. The work will be carried out in sections, the rails being laid suitable for the proposed electric traction.

Halifax.—Application is to be made to the Board of Trade for their sanction to the Corporation borrowing £10,000 for a generating plant and underground mains required in connection with the tramway extension. In laying mains for the tramways extensions provision will be made for electric lighting in Union Street, Market Street, Northgate End, North Bridge, Wards End, to Free School Lane, and from the bottom of Gibbet Street to the Fire Brigade Station.

Newcastle.—The question of visiting other towns to see electric tramway systems was before the City Council last week. A visit will probably be paid to the Middlesbrough-Stockton line recently opened.

Paisley.—Having heard the definite proposals of the British Electric Traction Company with reference to their scheme of electric traction for the burgh tramways, the provost, magistrates, and a number of the town councillors proceeded last week to Glasgow, and had a conference with the Tramway Committee there regarding the proposed extension of the city tramway system to the burgh. Beside having a clear statement of the future intentions of the Glasgow Corporation, the question of the working of the Paisley lines was also fully gone into. It is stated that the lines of an agreement between the two bodies were arranged. The town clerk of Paisley and Mr. Johnstone, of the Glasgow town clerk's office, were empowered to put the agreement into form, and submit it to the Paisley Corporation. The Light Railway Commissioners' inquiry into the application of the British Electric Traction Company, authorising light railways in the counties of Renfrew and Lanark, takes place on Tuesday, 20th inst.

Russia.—Two of the horse tramways in Moscow are being converted into electric lines, and a large central station is being erected to supply the necessary electrical energy.

Southport.—An extraordinary general meeting of the Birkdale and Southport Tramway Company was held on 9th inst. to consider the proposed sale of the company's system to the British Electric Traction Company, Limited. The Chairman went at length into the negotiations with the company, and the terms of the agreement. The conditional agreement was then unanimously approved and ratified, and the directors were empowered to carry it into effect.

Sunderland.—The report of the deputation of the Tramways Committee on the question of electric traction is a most elaborate compilation. A copy of it is now before us. It contains the deputation's notes on the electric tramways of Hamburg, Brussels, Dover, and Leeds, and some excellent full page pictures of these systems are shown. The Sunderland borough engineer reports on the cable system, and the borough electrical engineer on electrical systems, the cost of construction and working expenses being given of trolley, accumulator, conduit, and cable systems. A schedule of tramway extensions, which the deputation considers desirable, is included. As we have already stated when giving some notes on this report the deputation recommends the adoption of the overhead wire system. This report in the useful form in which it has been put together makes an important addition to the already numerous publications of a similar character which have been issued by a number of other important towns in the kingdom. If such documents exercise much influence upon the municipal mind, there need be little doubt which way the tramway matter will turn at Sunderland. May Mr. J. F. C. Snell soon find himself busy with the equipment of the lines.

Swansea.—The application for an interim injunction restraining the Swansea Corporation from interfering with the work of re-laying the Swansea tramway system by the British Electric Traction Company, came before the Judge in Chambers in London on Tuesday, last week, when the whole question was referred to the Board of Trade.

Vienna.—The protracted negotiations between the Vienna Town Council and the Tramway Company, based upon the proposals submitted by Messrs. Siemens & Halske, of Berlin, have now, according to a financial contemporary, been brought to a successful issue. Under the agreement entered into, the local authority will acquire the tramways and lease them to a new company until the year 1925, the whole of the lines to be converted to the electric system. The new company to be constituted will pay 40 per cent. on the net receipts to the local authority by way of rental, and at the expiration of the concession the whole of the plant and equipment will pass into the possession of the town without payment.

Wolverhampton.—At a special meeting of the Town Council on the 12th inst. Alderman C. T. Mander (chairman of the Tramways Committee), moved: "That in pursuance of the provision of the Tramways Act the Council resolved that, subject to the approval of the Board of Trade, notice be given to the Wolverhampton Tramways Company, Limited, requiring them to sell to the Council so much of the undertaking of the said company as is within the borough, and as was authorised by the Wolverhampton Tramways Order, 1877, as confirmed by the Tramways Orders Confirmation Act, 1877." Alderman Mander said the matter was a purely formal one, and if the Council voted against it the company would have another seven years' lease. The resolution was passed unanimously.

TELEGRAPH AND TELEPHONE NOTES.

Fire Alarms and Telephones.—The Fire Brigade Committee of the London County Council, in the course of a report, say:—"For a long time past the question of utilising the fire-alarm posts for the transmission of telephonic messages has been under consideration. After considerable inquiry and investigation the chief officer has devised an arrangement by means of which a portable telephone, to be carried on an engine, can be plugged into a fire-alarm post. This will enable a message from a fire to be sent by telephone, and will in many cases obviate the necessity of sending back a coachman with a written message. Arrangements have been made with the Post Office, which provides and maintains the fire-alarms for the Council, to supply the necessary telephones, and to make plug-holes in the alarm posts."

Manchester Telephone Service.—The telephone service is exciting attention, and it is understood that the Postmaster-General is still considering the application of the New Mutual Telephone Syndicate to be allowed to set up a rival system to that of the National Telephone Company.

The Pacific Cable.—From the Australian press we gather that last month the Premier of Queensland learned from the Prime Minister of New South Wales that an informal conference had been held in London on July 29th. Canada was represented by the Postmaster-General and High Commissioner of the Dominion. New South Wales, Victoria, Queensland, and South Australia were represented by their respective Agents-General. The Imperial Government and the Governments of Western Australia and Tasmania were not represented. The Canadian representative suggested that Canada would probably guarantee two-ninths of the total cost, but no more, and the Postmaster-General of the Dominion undertook to do his best for the scheme on this basis. The contribution of the Imperial Government, it was stated, would certainly not exceed one-third. The conference inquired whether the Australian Governments would guarantee the remaining four-ninths. This inquiry is now receiving the consideration of the different Australian Governments. The Premier of New South Wales further states that the Australian Governments have been for some months moving in the matter of the Pacific cable. The communications are, however, confidential.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Amazon Company's cable—		
Cable beyond Gurupa ...	June 8th, 1898 ...	...
Accra-Kotonou	Aug. 8th, 1898 ...	...
Bolama-Bissao	June 31st, 1898 ...	...
Cyprus-Latakia	Feb. 10th, 1898 ...	...
Perim-Assab	Sept. 13th, 1898 ...	...
Landlines.		
Indo-European Company's ...	Sept. 9th, 1898 ...	Sept. 9th, 1898.

The Telegraph Wire Export Trade.—August has proved to be one of the busiest months of the year in the export trade of this country in telegraph wire and apparatus connected therewith; the returns just issued showing a total for the past month of no less than £265,501 as compared with £45,600 in July last, and only £93,475 in August, 1897. The activity which has thus prevailed has brought about a great change for the better in the returns for the years to date, the value of the shipments this year to the end of August last being returned at £811,997 as compared with £700,748 in the corresponding period of last year, and only £461,578 in the first eight months of 1896.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—The Corporation invites tenders for the supply for one year, of electricity supply meters, house fuse boxes and house service cables. Mr. J. A. Bell, city electrical engineer. See our "Official Notices," September 2nd, for particulars.

Ashton-under-Lyne.—October 3rd. The Corporation Market Committee is prepared to receive tenders for the installation of the necessary wires, fittings, &c., for the electric lighting of the public market. The current will be supplied from the town mains. Consulting engineers, Messrs. Lacey, Ollrehugh and Sillar, 78, King Street, Manchester. See our "Official Notices" this week.

Belgium.—October 27th. The municipal authorities of Ghent are inviting tenders until October 27th for an installation of electric lighting in the new Flemish theatre in that town. Tenders to L'Hotel de Ville, Ghent, Belgium, from whence particulars may be obtained.

Bexhill.—September 28th. The District Council is inviting tenders for the supply of water-tube boilers, dynamos, and balancer, switchboards, accumulators, cables, pipes, arc lamps, and posts. Specifications, &c., from the consulting engineer, Mr. A. H. Preece, 39, Victoria Street, S.W.

Ghent.—October 29th. The Ghent Municipal Council is inviting tenders for the installation of the electric light at a new theatre. The work, says *Daily Tenders and Contracts*, has to be completed by June 1st, 1899 (a fine being imposed for every additional day to completion), and maintained for 12 months. Labour clause. The contract includes the supply and delivery of 1,337 incandescent lamps, 20 arc lamps, &c. All expenses for registering, stamps, notices, &c., which are estimated to cost 130 francs, to be paid by the contractor. A deposit of 8,000 francs is required, on which 2 per cent. will be paid after 60 days. Specifications seen with, and plans obtained, on payment of 40 francs, from M. Le Sécrétaire Communal (A. De Bruycker), Gand, or at the office of the paper mentioned above. Tenders, on stamped paper, registered, addressed as directed, with a certificate of deposit, to be posted by October 27th. The tenders will be opened at 11 a.m. on October 29th.

Halifax.—September 19th. The Tramways Committee invites tenders for the supply of car trucks and electrical equipment. Specifications and particulars from the borough electrical engineer, Mr. T. P. Wilmshurst, on payment of £1 1s. See our "Official Notices" last week.

Hull.—September 29th. Tenders are wanted for the supply of steel roofs for the extension of the Corporation electric light station. For particulars write to the city engineer, Mr. A. E. White, at the Town Hall.

Ireland.—September 27th. The Great Northern Railway Company (Ireland) is inviting tenders for the construction of about two miles of tramway alongside the public road from Sutton to the Baily Post Office (Sutton and Howth Electric Tramway). Drawings and specimens at the office of the engineer-in-chief, Amiens Street Terminus, Dublin.

Leeds.—September 20th. The Council require tenders for the supply of poles and trolley wire and attachment in connection with the electric tramway extensions. Particulars from the representatives of the late Dr. John Hopkinson, 26, Victoria Street, S.W., or from the City Engineer, Leeds. See our "Official Notices" last week.

Kingston-upon-Hull.—September 21st. The Corporation invites tenders for the erection of a tramway power station. For forms of tender and further particulars apply at the City Engineer's Office.

Kingston-upon-Hull.—September 30th. The Corporation want tenders for the supply of 45 electric motor cars, 20 trailers, 2 sprinkler cars, and 2 traversing platforms. Specifications from Mr. White, city engineer. See our "Official Notices" August 19th.

New South Wales.—October 17th. The New South Wales Government is, according to *Daily Tenders and Contracts*, inviting tenders for the supply for the Department of Posts and Telegraphs of a steam engine and dynamo, 218 tons galvanised iron wire, 90 tons copper wire, 70,000 porcelain insulators, 16,000 zinc cylinders, 16,000 lead ditto, 50 tons copper vitriol, 1,000 bottles ink for Morse instruments, 1,500 telephones, 1,000 batteries (Leclanché), 10,000 porous cylinders for same, 15,000 zinc ditto, 24 arc lamps, with 22,000 carbons, and 2,000 incandescent lamps. Further particulars, &c., obtained from, and tenders to, the Secretary, General Post Office, Sydney, N.S.W.

Plymouth.—October 6th. The Corporation want tenders for the supply of an enclosed (ironclad) continuous current motor, shunt wound, for 10 B.H.P. at 850—950 revolutions, for 520-volt circuit, complete with spare armature, starting switches, and resistances. Borough electrical engineer, Mr. J. H. Rider. See our "Official Notices" this week.

Portrane.—October 3rd. The Board of Control, Custom House, Dublin, is inviting estimates for the supply and erection of an electric light installation for Portrane Lunatic Asylum, County Dublin. See our "Official Notices," September 9th, for particulars.

Rathmines and Rathgar.—October 5th. The Electric Lighting Committee is inviting tenders for the supply and erection of Lancashire boilers, mechanical stokers and other boiler house plant, also high speed steam dynamos, condensing plant, overhead traveller, switchboard, underground cable work, cables, posts for incandescent street lighting, street lanterns, and incandescent lamps and meters. Consulting engineer, Mr. Robert Hammond. See our "Official Notices," September 9th, for further particulars.

Rotherham.—September 26th. Tenders are being invited, says *Daily Tenders and Contracts*, for the lighting of Thryberg Colliery, Rotherham, by electricity. Further particulars and permission to inspect obtained from Mr. W. Hargreaves, agent, Rothwell Kaign, Leeds. Tenders to Messrs. J. & J. Charlesworth, Limited, colliery proprietors, Milnes House, Wakefield.

Roumania.—September 22nd. Tenders are being invited until September 22nd by the municipal authorities of Braila, Roumania, for the concession for the electric lighting of the town. Particulars may be obtained from, and tenders are to be sent to, La Mairie de Drails, Roumania.

Spain.—October 3rd. Tenders are being invited by the municipal authorities of Almagro (Ciudad Real) for the concession for the electric lighting of the town. Tenders to be sent to El Secretario del Ayuntamiento de Almagro (Ciudad Real), Spain, from whence particulars may be obtained.

Torquay.—September 19th. The Electricity Supply Committee wants tenders for the supply of meters and arc lamp carbons for a period of 12 months from October 1st, 1898. Borough electrical engineer, Mr. P. Storey. See our "Official Notices," September 2nd, for particulars.

CLOSED.

Halifax.—We understand that it is proposed to accept the following tenders in connection with the Corporation electric tramways:—Leeds Steelworks Company for the supply of about 1,000 tons of steel rails and 47 tons of fish plates at £6 10s. per ton. Macartney, McElray & Co., poles and brackets, amounting to about £4,718.

Cardiff.—The following is a list of the tenders recently submitted to the Corporation for electric lighting plant:—

Name.	Price.	Engine.	
Parsons & Co., Newcastle ..	£2,425 0 0	Turbine.	Not the plant asked for.
W. H. Allen & Son, Bedford ..	£2,760 0 0	Own make.	
Brush Electrical Engineering Company, Loughborough ..	£3,126 0 0	Universal.	
Siemens Bros. & Co. (accepted), 287, London..	£3,130 0 0	Belliss.	
Easton, Anderson & Goolden, Erith	£3,179 0 0	Willans.	
Ferranti, Limited, Hollinwood	£3,250 0 0	Own make.	
General Electric Company, London..	£3,310 0 0	Willans.	
Mather & Platt, Manchester .	£3,332 0 0	Belliss.	
Siemens Bros., London	£3,350 0 0	Willans.	
Electric Construction Company, Wolverhampton	£3,450 0 0	Belliss.	
Mather & Platt, Manchester ..	£3,559 0 0	Willans.	
J. Fowler & Co.	£3,624 0 0	"	
Electric Construction Company	£3,685 0 0	"	
Ferranti, Limited, Hollinwood	£3,800 0 0	"	
Ditto ditto ..	£3,900 0 0	Belliss.	

NOTES.

A Simple Positive Blue Print Process.—Mr. J. D. Isaacs, of the South Pacific Railway Company of San Francisco, writing to the American *Engineering News*, says:—

We have recently worked out the following simple and practical process for making positive blue prints—that is, prints having blue lines upon a white ground, and find it very convenient for the rapid duplication of standard drawings, and of maps upon which subsequent plotting or colouring is desired. No special skill is required to work it.

We make our tracings with strong, black lines, using Higgins's "American White Label" India-ink. A paper negative is first made on ordinary photographic silver printing-out paper, such as Solio, or Kloro paper. We use the "Victor Special" brand, which can be had in rolls 25 inches by 30 feet, and is not expensive. To make the negative, cut the paper ½-inch larger each way than the tracing; place the tracing in an ordinary blue-printing frame, face up—that is, with the side drawn upon away from the glass; on this place the paper face down, so that the inked lines and the sensitised surface are in contact; then print in the sun to a dark coffee colour. The print is soaked in water, until drippings from it are no longer milky. It is then placed in a fixing bath made up about as follows (exactness is not important): Hypo-sulphate of soda 1 ounce, water 25 ounces.

The print will change in this bath to a uniformly light mahogany colour or dark buff. After becoming uniform in tint, it is left in the bath five or 10 minutes longer. It is then removed and washed for half an hour, then allowed to dry thoroughly, after which it will be much darker. When thoroughly dry the back of the negative should be given three good coats of the following varnish:- Canada balsam, 1 part by volume; spirits of turpentine, 3 parts by volume; alcohol, 2 parts by volume. Apply quickly with a sponge. Let each coat dry before applying another. Work in a warm room.

The result is a fairly transparent negative (reading backwards) of a non-actinic colour, with clean white lines and figures, from which the positive blue prints are made on ordinary blue print paper. Printing takes about twice as long as in the case of those ordinarily made from a tracing, but several negatives can be made from one tracing if many prints are required. When through printing we file the negatives with the tracings for future use.

The best method of getting the time of exposure for making the negative is to try one or two scraps of the paper first under the tracing, and note the time giving the best negative, after which uniform results can be had without difficulty. At this season of the year (May) the printing requires 3½ minutes in the sun in the middle of the day, under a clean tracing. If here and there a line or figure in the negative is indistinct from bad contact in the printing frame, it may be easily "doctored" by scratching with a pin point or other sharp point through the gelatine surface of the paper after the negative is otherwise finished. A fresh fixing bath should be used for each batch of negatives made. Before making the positive blue prints, test a small scrap of the blue print paper by washing before exposure to the light. It should wash clean, leaving no bluish cast to the paper. Soaking and washing the paper negatives, as above, may be done in the blue print washing tray in which blue prints are being washed, as the two processes do not affect each other.

Motor Cars in Paris.—The final examination for the newly created appointment of inspector of motor car traffic in Paris, took place on Thursday last week. There were some dozen competitors eager to be nominated for this important post. The successful candidate now bears the title of inspector of the traffic of vehicles propelled by mechanical motors. The salary is £120 per annum, and £20 for travelling expenses, and considering the popularity of the autocar in Paris, the post is not likely to prove a sinecure.

Electrical Power in Rolling Mills.—Though hydraulic and pneumatic transmission have each their particular duties in an iron mill, Mr. Eugene B. Clark shows the economy and convenience of electricity in a paper recently presented to an American Society of Engineers. A steel works covers so much ground that an old-fashioned method of driving involves either several independent steam plants or much steam pipe. Electrical transmission is now *facile princeps* as a means of driving a steel works. The uses of electricity in a steel works are:—(1) Lighting; both arc and incandescent, and preferably the arcs should be in series. For inside work constant potential closed lamps possess many advantages over open arcs. They burn longer, and do not interfere much with the regular work of the place when requiring trimming. Long distance incandescent lamps ought to be on an alternating circuit for the sake of economy in transmission. (2) Series motor operation.—This covers cranes, hoists, conveyers, charging machines, table rolls, transfer cars, &c. They are all intermittently operated, and cause no loss in transmission lines when not running. (3) Shunt motors intermittingly operated. This covers lathes, pumps, shears, fans, and other machine tools. They operate more steadily than series motors. (4) Shunt motors operated continually. These apply to grinders, crushers, pumps, and such machinery as is operated all the time. (5) Incidental uses covers lifting magnets, signals, testing devices. Upon the design and balance of the foregoing plant depends the economy of an installation. With direct current plant it is not the motor which now gives trouble, but the controller, and for an entirely new plant it is a question to choose the correct current, alternating or continuous. Voltage is most suitable at 220 or 250, the latter for the larger plants. A fair but not excessive margin of power must be provided. A few load curves are given as examples from which some idea may be gathered of the nature of the duty at a steel works. An average diagram can be found by superposing a number of daily curves. In 24 hours the fluctuation was observed to be as follows:—At 6 a.m. the load is 400 amperes, increasing rapidly to 700 at 7 a.m. Just before noon it runs up 100 or 200, and falls to 400 just before 1 o'clock, runs up a little before 6 p.m., and drops after 6 p.m. The cycle is repeated during the night, but the loads are a bit heavier, because of the light. Actual variations are numerous and sudden, the battery, if there is one, however, evens these out. Three distinct variations are observable. Rapid oscillations at the rate of one per second, others with a 30 minutes' periodicity, and the six hours' variation. Increase of plant, without a battery, renders more uneven the load fluctuation at the six-hour period, and reduces the first class of fluctuations, leaving the second unchanged. An accumulator would enable double the plant to be operated with the same generating power. In such case the author would place the motor load and light load on their own circuits, and he would compound the battery with a differential wound booster, and thus automatically regulate the load and voltage in the light circuit to a constant amount. For such a use, that is, as a regulator, the storage battery is very well adapted. It is very useful, also, to run light loads when the steam plant is shut down, as on Sunday.

Simla Water-Power Scheme.—It is understood, says an Indian newspaper, that the proposed scheme to obtain water-power from the Sutlej to be transmitted electrically up the hill for use at the spring water pumping stations instead of steam, and also for electric lighting, is considered possible, but financially impracticable at present or in the near future.

Electricity for Tunnel Haulage.—The passage through the St. Gothard tunnel is described to us by a recently returned traveller as having been something appalling during the recent hot season. With smoking locomotives burning briquette coal the journey of 9¼ miles, which occupies about 20 minutes, is almost unbearable. Our informant states that there is not far from the tunnel mouth a stream of fair size, which falls about 1,100 feet in a course of four miles by road, so that the water could easily be piped to Goeschenen, a distance of 2¾ miles by road from the Devil's Bridge, nearly 1,000 feet above Goeschenen, and utilised on Pelton wheels to work the tunnel by electricity.

The American Electro-Therapeutic Association.—The eight annual meeting of this Association has been held on Tuesday, Wednesday, and Thursday this week (13th, 14th, and 15th) at Buffalo, N.Y. The programme included an exhibition of electrical apparatus for diagnostic, therapeutic and radiographic work. Arrangements were made for a series of 10-minute discussions on electrotherapy, of special interest to the general practitioner, including Effect of Electricity on Tissue Metabolism, Electro-diagnosis, Diseases of the Nervous System, Diseases of Women, Genito-urinary Diseases, Maglignant Growths, Orthopædic Uses, Diseases of the Eye, &c. The following papers were promised :—

Dr. Apostoli, Paris, France, "Note on New Applications of the Sinusoidal Current in Electro-Therapeutics"; Dr. Gautier, Paris, (1) "The Hydro-electric Bath with Sinusoidal Current in Disease;" (2) "On the value of the Hot Air and Light Bath in Disease;" (3) "Two years of Practice in Radiotherapy;" (4) "Electrotherapy in Gynæcological Applications;" Dr. Felice La Torre, Rome, Italy, "Electricity in the Cure of Uterine Fibromyomata;" Dr. J. Inglis Parsons, London, England, "The Effect of High Tension Discharges upon Micro-organisms;" Mr. Nikola Tesla, New York, "High Frequency Oscillator for Electro-therapeutic Purposes;" Dr. Wm. C. Krauss, Buffalo, "Case of Lightning Stroke without Serious Consequences;" Dr. Lucien Howe, Buffalo, "The Method for using Cataphoresis in Certain Forms of Conjunctival Inflammations;" Dr. John O. Roe, Rochester, N.Y., "The uses of Electricity in Diseases of the Nose and Throat;" Mr. J. J. Carty, E.E., "New York Cataphoresis;" Dr. J. H. Kellogg, Battle Creek, Mich., "The Electric Light Bath;" Dr. M. A. Cleaves, New York, "Metallic Electrolysis, with Laboratory Experiments;" (2) "Electrical Treatment of Inflammatory Exudates;" "Cataphoresis and Metallic Electrolysis," by Wm. J. Morton, New York; Dr. W. J. Herman, Ann Arbor, Mich., "Electricity in Gynæcology;" Dr. A. D. Rockwell, New York, "Diagnostic and Therapeutic Relation of Electricity to Diseases of the Central Nervous System"; Dr. Grover W. Wende, Buffalo, "Electricity in Acne Vulgaris and Acne Rosaceæ;" Dr. Caleb Brown, Sac City, Iowa, "Cataphoric Action of the Galvanic Current;" Mr. R. G. Brown, E.E., Brooklyn, (1) "New Electric Light for Diagnostic Purposes;" (2) "Surface Electrodes, How they should be Made, Connector Cords, how they should be Made and Insulated;" Dr. Robert Newman, New York, "Electricity in Deafness and Strictures of the Eustachian Tube;" Dr. J. Nunn, Savannah, Ga., "Treatment of Uterine Fibroids by Small Currents Administered Percutaneously;" Dr. Wm. F. Robinson, Albany, N.Y., "Treatment of Certain Muscular Affections by Means of Electricity;" Dr. G. W. Overall, Memphis, Tenn., "True Status of Electricity and Allied Remedies in Treatment of Strictures and Prostatitis;" Dr. W. S. Watson, Fishkill-on-Hudson, N.Y., "Electricity and Medical Institutions;" Dr. W. H. White, Boston, Mass., "Static Electricity in Nervous Diseases;" Dr. H. S. Jewitt, Dayton, Ohio, "The Misuse or Abuse of Electricity as a Therapeutic Agent;" Dr. W. Scheppegrell, New Orleans, La., "Electricity in Diagnosis of Disease of the Ear;" "X Ray Burns," by Dr. W. H. Harris, Toronto, Ont. An illustrated lecture on the X Ray was to be delivered by Dr. Wm. J. Morton, New York.

The Association is to be congratulated upon its splendid showing of papers. One cannot but wish that this country paid the same amount of attention to electro-therapeutics as the members of the medical and electrical professions in America are doing.

Aqua Ammonia for Fire Extinction.—The *National Druggist* says that one of the best agents for extinguishing fires is aqua ammonia, without any addition whatever. Our contemporary has had personal experience with the almost marvellous power of this substance in this direction :—"In one instance where fire had originated, probably from spontaneous combustion, in a pile containing several tons of cotton seed, and the interior of which was almost a solid body of live coal, a half-gallon of ammonia completely smothered the fire. In another, which occurred at Savenay, France, the vapours of a tank containing 50 gallons of gasoline caught fire in the linen room of a laundry. The room was instantly a mass of living flames, but a gallon and a half of ammonia water thrown into it completely and almost immediately extinguished the fire. The ammonia was in a glass demijohn in an apothecary's shop next door to the laundry, and was thrown into the room by the druggist as an experiment. To use his own words in reporting the circumstance—in the *Union Pharmaceutique*—M. Janneau, the pharmacist, says: 'The effect was instantaneous—torrents of black smoke rolled upward in place of flames, and in a moment every trace of fire was gone. So completely was the fire extinguished, that workmen were enabled to enter the room almost immediately, where they found the iron tank of gasoline intact.'"

Electrical Work in Austria-Hungary.—The Vienna correspondent of the *Economist* gives some interesting notes on this subject :—"Whilst Vienna is sighing under the almost insupportable tyranny of having all its streets and thoroughfares dug up for the laying of perfectly superfluous gas pipes—since those that are in the ground would serve quite well until such time as gas is replaced by the electric light—the Bohemian cities are opening their gates wide to electricity, the works of which are established on a large scale, so as to serve for lighting purposes and motors for industrial concerns at the same time. The City of Komotau has just signed a contract with the Imperial Continental Gas Association in London for the introduction of electric power, and the current for industrial concerns to work machines, &c., will be delivered at 35 per cent. less cost than that required for lighting the city. The City of Warnsdorf is entirely lighted by electricity, Siemens and Halske being the firm that provides the supply. At present a narrow gauge electric railway is being built between Warnsdorf and Rumberg, both busy manufacturing towns, and plans for similar local railways are being worked out in many other towns of a similar character. Johannes is another town lighted by electricity, and Grottan is busy at present laying the cables for the streets, while many manufacturing establishments are already lighted by incandescent lights. In Morchenstern, another manufacturing town, large electric works are being built. The Town Council of Biela has just voted the necessary sum for electric lighting and electric tramways. In Aussig an electric city railway will soon be complete. Teplitz is quite a centre for electric works, and it is from there that a number of neighbouring cities are being provided with electric light and motive power. In the district of Bensen several manufacturing centres have been connected by an electric railway, and the motive power will be obtained by making use of two strong waterfalls, the property of two manufacturers. In Marienbad an electric railway from the station to the town will be built this winter, and another in Königgrätz. The electric tramway of Pilsen, one of the oldest towns of Bohemia, will be opened to the public on December 1st. The coal mines of Brüx, which are under Government management, are being provided with a complete system of ventilators, pumping engines, and railways all worked by electricity. From Prague quite a number of electric railways branch off to different industrial centres, and now all the tramways of the Bohemian capital are to be changed to electric railways. In the Tyrol some of the water-power which is favourably situated is also to be utilised. At present a company has been formed in Munich which will make the first trials with a waterfall of several thousand horse-power near Matrei. Some electrical and chemical manufactories in neighbouring towns have already subscribed for the motive power that is thus to be obtained."

Tacoma-Seattle Electric Light and Power Scheme.—The *Engineer* hears from Chicago that contracts have just been let in that city which will result in supplying the cities of Tacoma and Seattle with electric light and power on a scale equal, if not superior, to that furnished at Niagara. The project is perhaps the most wonderful development of hydraulic power yet undertaken in the United States. Snoqualamie Falls, which are to supply the power, are 22 miles from Seattle, and about the same distance from Tacoma, in an air line, and have an unbroken vertical fall of 270 feet. The waterfall is the only one of commercial utility west of Spokane. The flow of the river is equal to 30,000 H.P. at low water, and the plan of installation is such that, at a small additional expense for dams and reservoirs, the entire drainage from the snowfields of the Snoqualamie watershed of 1,000 square miles will be available, making over 100,000 H.P., whenever the business of the adjacent cities may demand it.

Costs of Running a Motor Car.—The Elliott Company of Oakland, Cal., claim that their 2-H.P. gasoline car costs 1½d per hour, and its purchase price is £150. It climbs a grade of 1 in 5 with two passengers, and can make 15 miles per hour on a good road. Its weight is about 700 lbs.

Electrolysis of the Alkali Salts of Organic Acids.—In a recent issue of the *Chemiker Centrablatt*, II., 518, there is a paper which has been taken from the *Bull. Acad. Roy. Danemark*, 397, the author of which was Julius Petersen, in which he carefully considers what happens when organic alkali salts are electrolysed. From the results obtained from previous investigators, supplemented by his own work on the electrolysis of acid solutions of the potassium salts of acetic acid and its homologues, the author represents the decomposition as taking place in accordance with the following equations :—

(1) $2\ C_n\ H_{2n} + 1\cdot CO_2\ H = 2\ C_n\ H_{2n} + 1\cdot CO_2 + H_2$.

(2) $2\ C_n\ H_{2n} + 1\cdot CO_2 + H_2\ O = 2\ C_n\ H_{2n} + 1\cdot CO_2\ H + O$.

(3) $2\ C_n\ H_{2n} + 1\cdot CO_2 = C_{2n}\ H_{4n} + 2\ CO_2$

(4) $2\ C_n\ H_{2n} + 1\cdot CO_2 = C_n\ H_{2n} + 1\cdot CO_2\ C_n\ H_{2n} + 1 + CO_2$.

(5) $2\ C_n\ H_{2n} + 1\cdot CO_2 + O = 2\ C_n\ H_{2n} + H_2\ O + 2\ CO_2$.

When a dilute acid solution of sodium formate is electrolysed, as the current intensity increases the amount of carbonic anhydride formed by oxidation of the acid decreases, but in a concentrated solution variation of current intensity has little effect on this action. As the concentration of the solution is diminished, more oxygen and less carbonic anhydride are liberated. The end products of the electrolysis of these acids are those of (3), (4), and (5). Acetic acid is decomposed mainly in accordance with (3) and (1); in this case, the formation of methylic acetate was confirmed. Propionic, normal butyric, and isobutyric acids are decomposed for the most part according to (5), and (4) becomes more important as (3) diminishes. In the case of propionic acid, ethylic propionic was found amongst the products of electrolysis. The quantity of butane liberated varied directly, and to the quantity of oxygen inversely, with the current intensity and the concentration of the solution. A solution containing 14 per cent. of the salt gave the maximum yield of ethylene. Butyric acid yields propylic and isopropylic butyrates. More hexane and propylene and less hydrogen are liberated when the current intensity or the concentration of the solution is increased. Isobutyric acid yields di-isopropyl and isopropylic butyrate. Variations of current intensity or concentration of the solution have the same effect as in the preceding case, but the amount of di-ispropyl formed is less than the amount of hexane obtained from the normal acid under like conditions. When oxalic acid is electrolysed, the current intensity has no effect on the nature of the products, but as the solution is diluted the amount of oxygen liberated increases. Malonic acid yields a small quantity of ethylene; the amount of carbonic oxide increases slightly with current intensity, but much more with the concentration of the solution. An acid solution of potassium succinate gives neither carbonic oxide nor acetylene. The amount of ethylene liberated, however, increases with the current intensity and the concentration of the solution much more than in the case of any other acid; a 0·5 per cent. solution of the salt with 1·5 amperes at 0° gave 0·25 per cent. of ethylene in the gas obtained; and a 40 per cent. solution, 23·7 per cent. of this gas. Isosuccinic acid yields, not only oxygen, hydrogen, carbonic anhydride, and carbonic oxide, but also traces of ethylene and acetaldehyde. Less oxygen is liberated than in the case of succinic acid, some of the oxygen being used for the formation of acetaldehyde. The amount of ethylene and of acetaldehyde both vary directly with the current intensity and the concentration of the solution. Phenylacetic acid yields small quantities of benzaldehyde and benzoylphenylic acetate in addition to oxygen, hydrogen, and carbonic anhydride.

Heavy Cable Tests.—Some recent cable tests, made in Germany, of wire cable 3·6 inches diameter, composed of six strands round a tarred hemp centre, showed that the breaking strain of the combination was 75 per cent. of the required test strength of the wires alone. The cable contained 1,080 wires of a total cross section of 2·8 square inches. The total tension was 550,000 lbs. The breaking stress was thus about 196,000 lbs. per square inch of cross section of wire.

When is an Arc Lamp Carbon not an Arc Lamp Carbon?—This is not a frivolous conundrum, says the *Financial News*, but a serious question which has recently arisen with regard to the duty payable on such imports into the United States. Under the Tariff Act of July 24th, 1897, a duty at the rate of 3s. 9d. per 100 was chargeable on imported carbons. Prior to the above date carbons were commonly imported in lengths of from 4½ inches to 14 inches, and occasionally as long as 16 inches, and even 20 inches. After the Act came into force, the carbons suddenly grew in length to 24 inches, 29 inches, and 36 inches each, evidently with the idea of circumventing the provisions of the Act. By cutting these sticks into ordinary lengths, importers would get practically 200 to 300 carbons, while only paying the tariff on 100. On this being discovered the Treasury Department issued instructions for charging every 12 inches, or part of 12 inches as a complete carbon; but the importers contested the legality of this, and Judge Somerville supported their view that the question of length could not be considered under the Act. But the Customs authorities were not to be beaten, and they have decided that rods of carbon a yard long are not arc lamp carbons, but come under another paragraph in the Act, which imposes a 35 per cent. *ad valorem* duty on "articles composed of carbon." Our contemporary's correspondent says that a revision of the Act is also talked of, so that the carbon manufacturers are probably now regretting their ingenious attempt to evade the exactions of the tariff.

New Developments in Central Station Plants.—The addition of a "400 kw. *detonator*" at the Tunbridge Wells electricity works, "only points to the fact that the electric lighting in the borough has a great future before it." So says a local scribe in the *Tunbridge Wells Advertiser!* An exceptional future, forsooth! "Already there are three 75-kilowatt *detonators* and one 25." The writer says that he recently visited the works, and had the "wonderfully intricate machinery" explained to him by one of Mr. Boot's assistants. He apparently has not profited by the assistance given to him, for he proceeds to say: "The *detonators* already in working order are more than sufficient to keep up the current." "The new *detonator* is to be worked by a high and low pressure cylinder." "It must not be thought that the lighting of Mount Ephraim has necessitated the building of the massive engine." We will spare our readers, and quote nothing more from this article. We will only ask, "When is an alternator not an alternator?" and our local scribe provides the answer, "When it's a *detonator*." "When is a *detonator* not a *detonator?*" "When it's a massive engine," we are told.

The Smoke Nuisance at Pittsburg.—In a recent issue the *American Manufacturer* remarks that the municipal authorities of Pittsburg have begun another crusade against the smoke nuisance, and tests of the steam plants at various establishments are now being made. The best feature of this movement is that common-sense methods are to be used, and the investigation is not to be made for the purpose of introducing any particular device. The official having the matter in charge is quoted, says our contemporary, as saying that the question of smoke abatement will be dealt with in a practical way, and he notifies all steam users within the city limits that, instead of putting them to any additional expense and trouble, in every case the plans he proposes to put in operation will mean the saving of at least 15 per cent. He states that investigation so far has shown that the smoke nuisance is due, first, to improperly constructed furnaces; second, to a lack of ample boiler room; and third, inadequate means to keep the flues and boilers free from scale and soot. The main trouble, he declares, is lack of ample boiler capacity, as this causes the boilers to be driven to their utmost, and great quantities of smoke are the inevitable result. Therefore the generating capacity of the boilers should be sufficiently in excess to easily meet the requirements for power. The foregoing plain facts are too often lost sight of in dealing with the smoke question. In attempting to abate the nuisance too little attention is paid to the condition under which a steam power plant is being operated. Instead of working by the best methods, and providing a plant able to meet requirements, an inadequate equipment is pushed beyond its proper limits, and the owners then hunt for some device that will accomplish impossibilities.

The Economical Carboning of Arc Lamps.—There is an article in the New York *Electrical Engineer* on this subject by Mr. W. J. Clarke. He says:—"For some unaccountable reason it seems that but few lighting stations are aware of the fact that it is possible to reduce greatly their operating expenses by giving proper attention and study to the carboning of the arc lamps. The large majority of the stations have for years been using double carbon lamps, in order that it may be possible for them to operate the lamps all night, or for two nights where the lights are extinguished at midnight. Now it is quite possible to give just as good, if not better, results by so carboning the lamps that a double lamp will run two whole nights of 14 hours each, and in this way it will be readily seen that the number of trimmers will be reduced one-half, on account of the fact that while one man can carbon, say, 50 lamps per day, where each lamp will only burn one night, it is quite possible for the same trimmer to carbon just double the number of lamps if they are so carboned as to burn two whole nights. This reduction in trimmers is accomplished by each man taking a circuit of 100 lamps instead of 50, and carboning one-half of them each day. It may at first seem strange that the number of hours that an arc lamp will burn may be nearly doubled by a slight change in the carboning as well as in the current; but the writer has proved again and again by practical experience that this can be quite readily accomplished by using $\frac{5}{8}$-inch plain carbons in the upper holders and $\frac{1}{2}$-inch copper-coated carbons in the lower holders, and then reducing the current on the line from 9½ to 9 amperes. It will, of course, be necessary, as soon as this is done, to alter slightly the adjustments of the lamps, but the larger carbon in the upper holders has the effect of giving the appearance of a much steadier and stronger light than formerly, so that the city authorities usually consider that the service has been greatly improved just as soon as the change has been made."

Fly-wheel Accident.—A fly-wheel at the Penistone works of Messrs. Charles Cammell & Co. burst recently into a score of pieces. It was the fly-wheel of a rolling mill, was 30 feet in diameter, and weighed 40 tons. It killed two men, and a quantity of machinery was wrecked. It appears that the governors of the engine were out of order, and regulation had to be effected by hand. Just before the accident the attendant had left the engine room to attend to other work a few yards away. Rolling was in progress when he went out, and apparently it must have been over when he returned, and probably the engine ran away, not being governed, and the fly-wheel burst, the attendant having his hand on the wheel ready to stop the engine, and standing by until it did stop. There was no blame found attachable to anyone, but we think that where an engine has no governor, there ought to be great care exercised in always having a man to stand by to shut off steam when work is thrown off. Cast-iron is not very suitable for fly-wheels of any kind, the limit of 80 feet per second being soon reached and passed if an engine runs away for only a few seconds with so large a wheel.

New Chronograph.—The *Engineer* says that a chronograph has, according to the *Deutsche Uhrmacher Zeitung*, been invented, which is said to excel by far all former achievements in this field, and to admit of measuring one-millionth part of a second and even smaller spaces of time. The apparatus is based on the following principle:—At the end of a tuning fork of a very high number of vibrations, a hole is provided, through which a pencil of rays falls upon the case of a revolving cylinder, whose circumferential velocity is 30 metres per second. In consequence of the quick vibration of the tuning fork and the rotation of the cylinder, the said luminous tuft describes upon the cylinder—which is doubtless covered with paper sensitive to light—a curve whose dimensions correspond to certain particles of time.

Obituary.—We regret to announce the death at Kurrachee of Lieut.-Col. H. L. Wells, C.I.E. and R.E., Director of Telegraphs, Persian Gulf, from enteric fever. He was 48 years of age.

British Association.—Next year's meeting of the B.A. will be held at Dover, the president for the year being Prof. Michael Foster. The 1900 meeting will take place at Bradford.

Presentation.—On the occasion of the retirement of Mr. Stewart from the position of electrical engineer-in-chief of the Corporation Electricity Supply Works, Derby, with which he has been connected from their inception, the staff showed their esteem and appreciation by presenting him with a walnut cabinet of dessert knives and forks. The presentation was made on Friday afternoon, September 9th. The cabinet bears a silver plate with suitable inscription.

The Institution of Junior Engineers.—On Saturday, September 24th, a visit will be paid to Sir David Salomon's workshops, laboratories, &c., at Broomhill, Tunbridge Wells. Train leaves Cannon Street at 1·35 p.m. Tickets from the Secretary, 47, Fentiman Road, London, S.W.

NEW COMPANIES REGISTERED.

Bunce Bros. & Co., Limited (58,773).—This company was registered on September 8th, with a capital of £3,000 in £1 shares, to acquire and carry on the business of manufacturers of electrical fittings and accessories, engineers, iron and brass founders, &c., carried on as "Bunce Bros. & Co." at Savile Park Street, Halifax, and to adopt an agreement with John E. Bunce. The subscribers (with one share each) are:—John E. Bunce, Elmfield House, Halifax, electrical fittings manufacturer; Walter Midgley, 8, Harrison Road, Halifax, solicitor; Harry Skelton, Pinder Farm, Pellon, butcher; S. Wallace Turner, Boar's Head Hotel, Halifax, hotel proprietor; Geo. R Pearson, 15, Southgate, Halifax, tailor; Lawson Saville, India Buildings, Halifax, dealer in pianos, &c.; Herbert Siddall, 16, Cornmarket, Halifax, tailor. The first directors are: John E. Bunce, Joseph Bunce, and Lawson Saville. Qualification, £50; remuneration as fixed by the company.

George F. Milnes & Co., Limited (58,795).—This company was registered on September 10th, with a capital of £150,000 in £10 shares, to acquire and take over as a going concern the business now carried on at Birkenhead and elsewhere under the style or firm of "George F. Milnes & Co.," to enter into an agreement with William H. Edwardes, and to carry on the business of manufacturers and builders of, and dealers in, cars, carriages, waggons, tramcars, tramways, wires, poles, motors, electrical apparatus, cable apparatus, omnibuses, freight cars, &c. The subscribers (with one share each) are:—George F. Milnes, Bella Vista, West Kirby, car builder; William W. Rutherford, 43, Castle Street, Liverpool, solicitor; William H. Edwardes, 4, Olive Mount, Wavertree, oil refiner; Albert Hughes, 69, Park Road East, Birkenhead, car builder; Alexander Bruce, Ballaquayle Villa, Douglas, Isle of Man, banker; Henry A. Watson, Monkswell, Wavertree, broker; and Charles H. Rutherford, 43, Castle Street, Liverpool, solicitor. The number of directors is not to be less than three nor more than seven. The first are: George F. Milnes, William H. Edwardes, Alexander Bruce, and William Busch. Qualification, £1,000; remuneration as the company may decide.

Arcas Standard Silver Plating and Manufacturing Syndicate, Limited (58,801).—This company was registered on September 10th, with a capital of £10,000 in £1 shares, to acquire British patents No. 13,460 of 1891 and No. 1,391 of 1892, granted to Sherard O. Cowper-Coles and the London Metallurgical Company, Limited, for "Improvements relating to the coating of articles with a new metallic alloy by electro-deposition," to adopt an agreement with A. F. B. Gomess, and to carry on the business of silversmiths, electro-platers, and silver-plated ware manufacturers. The subscribers (with one share each) are:—C. Brownfield, 88, Drayton Gardens, South Kensington, gentleman; A. F. B. Gomess, F.C.S., 33, Drayton Gardens, S W.; S. R. Glyn, 48, Bedford Row, W.C., solicitor; W. T. Bell, 53, South Park Road, Wimbledon, accountant; F. G. Beaumont, 307, Victoria Park Road, N.E., clerk; S. J. Wilkinson, 4, Gascony Road, West Hampstead, clerk; S. Cowper-Coles, Grosvenor Mansions, Victoria Street, S.W., electrical engineer. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, £50; remuneration as fixed by the company.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

British Electric Meter Company, Limited (56,408).—This company's statutory return was filed on July 12th, when 225 shares were taken up out of a capital of £5,000 in £10 shares. The full amount has been called, and £1,511 9s. received, leaving £738 11s. in arrears.

Berrenberg Electric Lamp Syndicate, Limited (56,054).—This company's statutory return was filed on July 1st. The capital is £10,000 in £1 shares (100 founders'). 6,100 ordinary and the founders' shares have been taken up, and the latter are considered as paid. 5s. per share has been called on the others, resulting in the receipt of £1,525.

CITY NOTES.

Brush Electrical Engineering Company, Limited.

The ninth annual general meeting of the Brush Electrical Engineering Company was held at the Cannon Street Hotel on Monday, Mr. J. B. Braithwaite (chairman) presiding.

In moving the adoption of the report, the Chairman said the gross trading profit for the year was £9,768 more than last year, whilst the net trading profit showed an increase of £7,976; but in view of the fact that during the past year they had spent £1,847 more on the maintenance of their plant and buildings than in the previous year, the position was that, as far as their trading was concerned, they had retained the whole of their gross increase as net, which was, he thought, a satisfactory feature. He thought it showed that the expenditure which they had incurred on additional buildings and works at Loughborough had been fully justified, as they had been enabled to earn £10,000 addditional gross profit without any increase in administrative expenses. Coming to the details of the accounts, they would notice on the debtor side that, as for many years past, the directors had again waived half of the fees to which they were entitled under the articles. Now, however, that the ordinary shareholders were beginning to receive dividends, they thought that they, too, should share in the increased prosperity of the company, and therefore for the current year they proposed only to waive one-quarter of their fees. The total general charges came to £11,276, as against £11,970, showing a reduction of close upon £700. The item of £283, reduction of capital expenses, would not, of course, recur again, and the entire removal of the head office had now been completed at the slight additional cost of £76. The amount spent on the maintenance of buildings and plant was £4,296. As he told them at the last meeting, on no account would the directors allow their plant or buildings to run down, but they were determined always to keep them up to the highest state of efficiency at the expense of revenue. The maintenance of patents also showed an increase. The interest on the first debenture stock, £5,625, was a standing item, but the interest on the second debenture stock showed a reduction of nearly £1,000, owing to their having redeemed £26,770 of the stock. The balance of profit carried to the balance-sheet was £26,938, being, as he had said, an increase of £7,976 more than last year. If they turned to the balance-sheet they would see on the credit side that they had again incurred considerable expenditure in additions to their works. They had spent altogether during the year £17,569 in additions, or if they included the money received from the sale of their old Borough Road factory, the amount would stand at £21,500. The patents and goodwill stood at the same figure as last year. The stock showed a slight reduction of £1,580, which proved that the company was not engaged in making stuff which did not find a ready market. Their debtors showed a considerable reduction, owing to the fact that their friends, to whom they had advanced £45,000 on their engineer's certificate, had found it convenient to pay them. The soundness of the company was evidenced by the fact that, in spite of their having paid away in hard cash nearly £50,000, their cash position was nearly £25,000 better than it was last year. Turning to the debtor side of the balance-sheet, they would find that the capital had been reduced to the extent of £26,770 by the reduction of the second debentures. The creditors showed a slight increase of £1,000, but that was merely due to an accident. They proposed to distribute an extra £8,000, which would go as follows:—The full preference dividend would absorb an extra £1,459, and the dividend on the ordinary shares would absorb £5,400; the employés' bonus fund would absorb £11 more than last year, and £1,000 would go towards forming the nucleus of a workmen's Compensation Act insurance fund, and they carried forward to the next account an additional £107. With regard to the money they had spent at the works, it had been a real necessity, and directly they were completed they had been fully occupied in executing orders received. For instance, they had expended a considerable sum of money on building new car-shops, and before that was ready the orders had reached them to fill it. At present it was full of work, and they were seriously considering the question of doubling the shed, and they were afraid they would have to incur considerable expense in so doing. He supposed the orders came in consequence of the reputation they had for rolling stock. Another thing they had to do was to make further provision for the large increase of orders they expected in connection with electric traction. The tramcars they saw in the streets wanted electric motors to drive them, and these were required in very large numbers, and they were obliged to put up a special shop for no other purpose but to manufacture tramway motors. They had a shop now approaching completion, which he trusted would turn out 1,000 motors per annum, and they believed the shop would thoroughly justify its construction. The amount they were already committed to for additional expenditure for works was £25,000, not including the doubling of the car shop he had referred to. He was not anxious to extend their works, but at the same time, if they could obtain orders at remunerative prices for the buildings put down, it was to the interest of the shareholders that they should spend the money they had available. They had plenty of resources in hand, and he did not think they need fear that it would require any enlargement of capital. They had secured a plot of land adjoining the present works at Loughborough, which would give them 15 acres altogether in a capital situation, with the sidings of the Midland Railway running right into the works. With regard to the great lock-out he need not say much. They were approached by the Masters' Federation and asked to lock out their men although they had no quarrel with them; they did not see their way to comply with the mandate of the Employers' Federation, and their men therefore remained at work. Their relations with their men remained of the most cordial character, and he hoped they would long continue so. The men had done extremely well in the past year, and he hoped they would give even better results in the future. As regarded the orders executed in the year, they were drawn from a variety of sources. Last year he pointed out that one of the reasons why he thought the company was on a satisfactory basis was, that they did not obtain orders for any particular class of manufacture. Sometimes they had a run of orders for one thing and sometimes for another. The run last year was especially on rolling stock. In addition to the many tramway orders executed, they had orders for a considerable amount of rolling stock for the Central London Railway still in hand, and they had completed in the past year their first electric tramway. Electric traction had made comparatively slow progress in England, and people were naturally cautious. Consequently, although they received orders for the cars, it was specified that they should supply American made motors. That year they had gone a step forward and had equipped a tramway from top to bottom, and it had, been a great success. They believed that the English workman could make an electric motor as well as an American. Last year 33 per cent. of their orders were for rolling stock, 18 per cent. for dynamos, 17 per cent. for transformers, 13 per cent. for engines, and 8 per cent. for locomotives, while the balance of 11 per cent. was made up by miscellaneous items. In conclusion, the chairman referred to the profit-sharing scheme, and said although they had paid a sum equal to 1 per cent. to their workpeople, he believed they were doing the right thing. At present, about 200 workmen participated, but at a board meeting to follow that meeting they hoped to make a large addition to the number, and he hoped the time would come when all the employés would have a personal interest in making the company a great financial success.

Mr. B. H. Van Tromp seconded the motion, and it was agreed to.

Babcock & Wilcox Company.

The report for the year ended June 30th last states that the profit during the year, after deducting the amount written off purchase of business account, amounts to £75,757, which, with £5,656 brought forward from last account, gives a balance of £81,412. From this sum is deducted the interim dividends for the half-year to December 31st last at the rate of 6 per cent. per annum on the preference shares, and 10s. per share on 14,000 ordinary shares, amounting to £10,000, leaving £71,412, from which the directors recommend that dividends be paid for the half-year to June last at the rate of 6 per cent. per annum on the preference shares (from which income-tax to be deducted), absorbing £3,000, and of 25s. per share on the ordinary shares (free of income-tax), requiring £27,500, to place to a reserve fund £35,000, leaving a balance to be carried forward of £5,912.

Metropolitan Electric Supply Company.—The Board has declared an interim dividend of 5s. per share on the original shares for the half-year ended June 30th last, payable on 23rd inst. The transfer registers will be closed from to-day to 22nd inst., both days inclusive.

Stock Exchange Notice.—The Stock Exchange Committee has ordered the under-mentioned securities to be quoted in the Official List:—Oxford Electric Company, Limited—10,000 shares of £5 each, fully paid, Nos. 1 to 96 and 407 to 10,310.

The Hove Electric Lighting Company, Limited.—The directors have declared an interim dividend at the rate of 5 per cent. per annum upon the share capital, payable on October 15th.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending September 9th, 1898, were £3,443 1s. 2d.; corresponding period, 1897, £2,495 15s. 9d.; increase, £947 5s. 5d.

The Cape Electric Tramways Company.—The receipts for February were: Cape Town, £8,250; Port Elizabeth, £2,225.

The City and South London Railway Company.—The receipts for the week ending September 11th, 1898, were £876; week ending September 12th, 1897, £879; decrease, £3; total receipts for half-year, 1898, £10,487; corresponding period, 1897, £9,906; increase, £581.

The Dover Corporation Electric Tramways.—The receipts for the week ending September 10th, 1898, were £244 10s. 8d.; total receipts to September 10th, 1898, £5,564 15s. 4d.

The Dublin Southern District (Electric) Tramways Company.—The receipts for the week ending September 9th, 1898, were £1,204 12s. 4d.; corresponding week last year, £579 6s. 0d.; increase, £625 6s 4d.; passengers carried, 165,043; corresponding week last year, 88,055; aggregate to date, £11,507 12s. 2d.; aggregate to date last year, £8,342 5s. 11d.; increase to date, £3,165 6s. 4d.; mileage open, 8 miles, as against 8 miles for the corresponding period of last year, and includes Traffic Pillar and Haddington Road.

The Liverpool Overhead Railway Company.—The receipts for the week ending September 11th, 1898, amounted to £1,528; corresponding week last year, £1,451; increase, £77.

The Mexico Electric Tramways.—Receipts for August, £15,000.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending September 9th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,577.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, September 7th.	Closing Quotation, Sept. 14th.	Business done during week ended Sept. 14th. 1898. Highest.	Lowest.
137,400£	African Direct Telegraph, 4 % Debs.	100	4 %	...	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	6 — 7	6 — 7	...	...
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	92 — 95	92 — 95	...	...
923,960£	Anglo-American Telegraph	Stock	£2 9s	£2 13s	3 %	64 — 67	64 — 67	64¼	...
3,038,020£	Do. do. 6 % Pref.	Stock	£4 18s	£5 6s	6 %	115½—116½	116 —117	116½	116
3,038,020£	Do. do. Deferred...	Stock	...	...	...	16 — 16½	16 — 16½	16 7/16	16¼
130,000	Brazilian Submarine Telegraph	10	7 %	7 %	7 %	15¾— 16¼	15¾— 16¼	16⅛	15⅝
75,000£	Do. do. 5 % Debs. 2nd series, 1906 ...	100	5 %	...	...	111 —115	112 —116	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	4 %	2¾— 3¼	2¾— 3¼	2¾	...
10,000,000$	Commercial Cable	$100	7 %	8 %	8 %	180 —190	180 —190	...	...
918,297£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	105 —107	105 —107	106¼	105¾
224,850	Consolidated Telephone Construction and Manufacturing	10/-	1½ %	2 %	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Telegraph	10	8 %	8 %	7 %	8½— 9½	8½— 9½	9¼	9⅛
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	15 — 16	15 — 16	15¾	15½
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000£	Do. do. 4½ % Debs., Nos. 1 to 6,000 ...	50	4½ %	4½ %	4½ %	102 —105%	103 —106%	...	...
60,710£	Direct United States Cable	20	2½ %	2½ %	...	11½— 12	11½— 12	11⅝	...
120,000	Direct West India Cable, 4½ % Reg. Deb. ...	100	...	...	...	100 —103	100—103	...	...
400,000	Eastern Telegraph, Nos. 1 to 400,000	10	6½ %	6½ %	7 %	17¾— 18¼	17¾— 18¼	18 3/16	17¾
1,295,000	Do. 3½ % Pref. Stock	100	...	...	...	103 —106	104 —107	105¾	105⅜
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	5 %	100 —103	100 —103	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	124 —128	125 —129	126½	125
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	17½— 18	17½— 18	17 15/16	17⅞
25,200£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	5 %	99 —103	99 —103	...	...
100,500£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	5 %	100 —103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	123 —127	124 —128	...	...
35,100£	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	99 —103	99 —103	...	...
46,500£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	100 —103	100 —103	...	...
300,000£	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	102 —105	102 —105	...	...
200,000£	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	4 %	...	104 —107%	104 —107%	...	...
180,227	Globe Telegraph and Trust	10	4½ %	4½ %	4½ %	12 — 12½	12 — 12½	12⅜	12 3/16
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	16¾— 17¼	16¾— 17¼	16⅞	...
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	10 %	29 — 30	29 — 30	...	...
160,000£	Do. do. do. do. 5 % Debs. ...	100	5 %	5 %	5 %	101 —104 xd.	101 —104	...	...
97,000	Halifax & Bermuda Cable, 4½% 1st. Mt. Dbs., w'n. 1-1,200, rd.	100	...	...	...	100 —104	100 —104	104	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	51 —54	51 — 54	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	6 %	110 —113 xd.	110 —113	...	...
28,000	Montevideo Telephone, 6 % Pref., Nos. 1 to 28,000 ...	5	4 %	4 %	4 %	2¼— 2¾	2¼— 2¾	...	...
484,597	National Telephone, 1 to 484,597	5	5½ %	5½ %	6 %	5⅜— 5⅝	5⅜— 5⅝	5 9/16	5⅜
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	14 — 16	13 — 15	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	14 — 16	13 — 15	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅜— 5⅝	5⅜— 5⅝	5½	5 7/16
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	100 —105	100—105	105	102½
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝— ¾	⅝— ¾	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	4 %	105 —108	105 —108	...	...
11,839	Reuter's	8	5 %	5 %	5 %	8 — 9	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 —141	136 —141	...	...
58,000	United River Plate Telephone	5	4 %	5 %	6 %	4¼— 4¾	4¼— 4¾	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	...	...	103 —106	103 —106	...	...
15,609	West African Telegraph, 7,501 to 23,109	10	4 %	*nil*	*nil*	3½— 4½	3½— 4½	...	...
213,400£	Do. do. 5 % Debs.	100	5 %	5 %	5 %	99 —102 xd.	99 —102	100¾	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ¾	¼— ¾	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	104 —107	104 —107	...	...
64,269	Western and Brazilian Telegraph	15	3 %	2 %	3½ %	12¼— 12¾	12 — 12½	...	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	5 %	8 — 8½	8 — 8½	...	...
33,129	Do. do. do. Def. Ord.	7½	1 %	*nil*	½ %	4 — 4½	4 — 4½	4 1/16	...
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	107 —110	107 —110	...	...
88,321	West India and Panama Telegraph	10	⅞ %	1 %	⅞ %	1 — 1¼	1 — 1⅛	1 1/16	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	6 %	9¼— 9¾	9¼— 9¾	9⅞	9⅛
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	6 %	6 — 8	6 — 8	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	5 %	105 —108	105 —108	...	...
1,163,000$	Western Union of U.S. Telegraph, 7 % 1st Mort. Bonds	$1000	7 %	7 %	7 %	105 —110	105 —110	...	...
160,100£	Do. do. do. 6 % Ster. Bonds ...	100	6 %	6 %	6 %	98 —103 xd.	98 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	5 %	6 %	7 %	12 — 13	12 — 13	...	...
20,000	Do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
26,000	*Chelsea Electricity Supply, Ord., Nos. 1 to 10,277... ...	5	5 %	5 %	6 %	8½— 9½	9 — 10	9½	...
60,000	Do. do. do. 4½ % Deb. Stock Red....	Stock	4½ %	4½ %	4½ %	113 —115	113 —115	...	...
50,000	City of London Electric Lighting, Ord. 40,001—90,000 ...	10	5 %	7 %	10 %	24½— 25½	24½— 25½	25 7/16	...
10,000	Do. Prov. Certs. Nos. 90,001 to 100,000 £5 ...	10	...	...	...	24 — 25	24 — 25	...	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½— 17½	16½— 17½	16 11/16	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	125 —130	125 — 130	127	...
30,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—30,000	10	*nil*	*nil*	*nil*	13 — 14	13 — 14	...	...
10,000	Do. do. do. Nos. 30,001 to 40,000 £6 paid.	10	...	...	...	8½— 9½	8½— 9½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	14 — 15	14 — 15	14½	...
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400	5	...	...	5 %	5 — 5½	5 — 5½	5⅝	...
10,000	House-to-House Electric Light Supply, Ord., 101 to 10,100	5	...	...	4 %	9 — 10	9 — 10	9¾	...
10,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	7 %	9½— 10½	9½— 10½	10	...
62,400	*Metropolitan Electric Supply, 101 to 62,500	10	4 %	5 %	6 %	16½— 17½	17½— 18½	18	17⅝
220,000£	Do. 4½ % First Mortgage Debenture Stock	...	4½ %	4½ %	4½ %	116 —120	116 —120	...	...
6,452	Notting Hill Electric Lighting	10	2 %	4 %	6 %	15 — 16	15½— 16½	16	...
31,980	*St. James's and Pall Mall Electric Light, Ord.	5	7½ %	10½ %	14½ %	17 — 18	17 — 18	17 1/16	17⅜
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	9 5/16	...
50,000	Do. do. 4 % Deb. Stock Red. ...	Stock	...	...	4 %	105 —108	105 —108	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2⅞— 3⅛	2⅞— 3⅛	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	16 — 17	16 — 17	16⅞	16⅝

* Subject to Founder's Shares.
‡ Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation Sept. 7th.	Closing Quotation Sept. 14th.	Business done during week ended Sept. 14th, 1898. Highest.	Lowest.
30,000	British Electric Traction	10	...	...	...	16½— 17	16½— 17	17	16¾
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.)	10	...	...	...	13 — 14	13 — 14	13 1/16	13 1/16
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	2½%	*nil*	*nil*	1¼— 2⅛	1⅝— 2	2⅛	1 15/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	2¼— 2⅛	2¼— 2½	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	107 —111 xd	107 —111 xd	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102—105	103	...
19,894	Central London Railway, Ord. Shares	10	...	...	...	9⅝— 10¼	10 — 10¼	10⅜	10 5/16
129,179	Do. do. do. £6 paid	10	...	...	...	5⅝— 6¼	6 — 6⅛	...	...
59,254	Do. do. Pref. half-shares £1 paid ...	...	...	...	...	1⅛— 1⅜	1⅛— 1⅜	1⅜	...
67,680	Do. do. Def. do. £5 paid ...	...	...	...	...	4½— 4⅝	4½— 5	...	...
630,000*l*	City and South London Railway	Stock	1 3/16 %	1 1/16 %	1⅞ %	70 — 72	70 — 72	...	...
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £3 pd.	10	...	...	...	2¾— 3¼	2¾— 3¼	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	1⅝— 2¼	1⅝— 2¼	...	...
82,850	Do. 5% 1st Mort. Reg. Debs., 1 to 743 of £100, and 901 to 1,070 of £50 Red.	...	...	...	...	89 — 94	89 — 94	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5 %	5½%	6 %	2¼— 2⅝	2¼— 2⅝	...	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5 %	5½%	6 %	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	101 —103	101 —103	101	...
110,000	Electric Construction, 1 to 110,000	2	5 %	6 %	6 %	2¼— 2½	2¼— 2½	...	...
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	7 %	2⅝— 3¼	2⅝— 3¼	...	...
111,100	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	105 —107	105 —107	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	⅜— ⅝	⅜— ⅝	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	¼— ½	¼— ½	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	7 %	7 %	10 — 12	10 — 12	...	...
12,500	Henley's (W. T.) Telegraph Works, Ord.	10	8 %	10 %	12 %	20½— 21½xd	20½— 21½	21¼	...
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18 — 19 xd	18 — 19	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	4½%	4½%	110 —115 xd	110 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	22 — 23	22½— 23½	23⅛	22¾
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	102 —106	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3½%	10 — 10½	10½— 10½	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15½— 16	15½— 16	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	38 — 43	39 — 43	41¾	40½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	100 —103	100 —103	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	126 —131	126 —131	131	128

† Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10⅛.
British Aluminium, Ordinary, 10⅛—11⅛; 7 % Pref., 12—13.
House-to-House, 4½% Debentures of £100, 105—108.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 14—15; 1st Preference Cumulative 6%, £5 (fully paid), 8—8½. Debentures, 105—108. Dividend, 1897, on Ordinary Shares 10%.
London Electric Supply Corporation, £5 Ordinary, 3½—4.
National Electric Free Wiring, 10s. paid, ⅜—½.
*T. Parker, £10 (fully paid), 13—13½.
Yorkshire House-to-House Electricity, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6%.

* From Birmingham Share List.

Bank rate of discount 2½ per cent. (June 30th, 1898).

MARKET QUOTATIONS, Wednesday, September 14th.

CHEMICALS, &c.		This week.	Last week.	Increase or Decrease.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a „ Nitric	per cwt.	22/-	22/-	..
a „ Oxalic	per cwt.	32/-	32/-	..
a „ Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per ton	37/-	37/-	..
a Ammonia, Muriate (grey) ..	per ton	£19	£19	..
a „ „ (white) ..	per ton	£26	£26	..
a Bleaching powder	per ton	£6 15	£6 15	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£14	£14	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a „ (50/90 %)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£17	£16 10	10s. inc.
a Lead, Nitrate	per ton	£23 10s.	£23 10s.	..
a „ White Sugar	per ton	£30 10s.	£30 10s.	..
a „ Peroxide	per ton	£27 10s.	£27 10s.	..
a Methylated Spirit	per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.)	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	3¾d.	3¾d.	..
a „ Caustic (75/80 %) ..	per ton	£24	£24	..
a „ Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	64/-	65/-	1s. dec.
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 10	£6 10	..
a „ Recovered	per ton	£5 10	£5 10	..
a „ Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£8 15	£8 15	..
a „ Crystals	per ton	£3	£3	..
a „ Bichromate, casks ..	per lb.	3d.	3d.	..

METALS, &c.		This week.	Last week.	Increase or Decrease.
b Aluminium Wire, in ton lots ..	per ton	£224	£224	..
b „ Sheet, in ton lots..	per ton	£191	£191	..
c Brass (rolled metal 2" to 12") basis	per lb.	6½d.	6½d.	..
c „ Tube (brazed)	per lb.	8½d.	8½d.	..
c „ Wire, basis	per lb.	6½d.	6½d.	..
f Ebonite Rod	per lb.	8/-	8/-	..
f „ Sheet	per lb.	5/-	5/-	..
g Copper Bars	per ton	£62	£61 15	5s. inc.
g „ Wire (basis price) ..	per lb.	7½d.	7½d.	..
g „ Sheet	per ton	£62	£61 15	5s. inc.
g „ Rod	per ton	£62	£61 15	5s. inc.
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha, fine	per lb.	5/6	5/6	..
h India-rubber, Para fine ..	per lb.	4/1½ forw'rd	4/2½ forw'rd	1d. dec.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i „ Pig (Cleveland warrants)	per ton	42/9	42/9	..
i „ Forgings, according to size	per ton	From £11	From £11	..
i „ Scrap, heavy	per ton	45/-	45/-	..
i „ Wire galvanised No. 8 ..	per ton	£8 15	£8 15	..
g Lead, English Ingot	per ton	£13	£13	..
g „ „ Sheet	per ton	£13 17 6	£13 17 6	..
l Mica	per lb.	5/6	5/6	..
m Manganin Wire No. 28.. ..	per lb.	8/-	8/-	..
g Mercury	per bottle	£7 9	£7 12	3s. dec.
o Platinum	per oz.	£2 16	£2 16	..
i Steel, Magnet, according to description	per ton	From £15	to £40	..
i Steel, Magnet, in bars		£58	£58	..
g Tin, block	per ton	£76 10	£76 10	..
g „ foil	per lb.	1/3	1/3	1d. inc.
j Yarns, Cotton, Single 10lb. bundles	per lb.	6½d.	6½d.	..
j „ Flax, 6 or 8 lea... ..	per lb.	3½d.	3½d.	..
j „ Hemp, 3 ply 10 lbs. ..	per lb.	3½d.	3½d.	..
j „ „ Russian, 10 lbs.	per lb.	4½d.	4½d.	..
j „ Jute, 180 lbs. rove ..	per ton	£11	£11	..
j „ Manila, 24 thread ..	per ton	£31	£31	..
k Zinc, Sheet (Vielle Montagne brand)	per ton	£25 10	£25	10s. inc.

a Quotations supplied by Messrs. G. Boor & Co.
b „ „ „ The British Aluminium Co., Ltd.
c „ „ „ Messrs. Thos. Bolton & Sons.
d „ „ „
e „ „ „
f „ „ „ The India-Rubber, G.-P., and Teleg. Works Co. Ltd
g „ „ „ Messrs. James & Shakspeare.
h „ „ „ „ Jackson & Till.
i Quotations supplied by Messrs. Bolling & Lowe.
j „ „ „ „ Henry C. Yeo & Co.
k „ „ „ „ Morris Ashby, Limited.
l „ „ „ „ Sanders, Wake & Co.
m „ „ „ „ W. T. Glover & Co., Ltd.
n „ „ „ „ P. Ormiston & Sons.
o „ „ „ „ Johnson Matthey & Co.

THE BRITISH ASSOCIATION.

(*Continued from page* 410.)

ELECTRIC POWER AND ITS APPLICATION ON THE THREE-PHASE SYSTEM TO THE BRISTOL WAGGON AND CARRIAGE WORKS.*

By W. Geipel.

While there have been several papers read in this country before engineering societies on the application of electric power in works, yet this subject does not appear to have been brought prominently before the members of the British Association.

It is presumably one of the purposes of this Association that man generally shall procure the greatest possible service from the sources of energy placed by Nature at his disposal, and that the subjects of this realm shall be in the van of progress in attaining this object; while it is well known that the waste of energy by the uneconomical use of coal is enormous, more especially in this country.

Lord Armstrong, in his Address to this Association at Newcastle in 1863, said that "the greatness of England much depends upon the superiority of her coal, in cheapness and in quality, over that of other nations; but we have already drawn, from our choicest mines, a far larger quantity of coal than has been raised in all other parts of the world put together; and the time is not remote, when we shall have to encounter the disadvantages of increased cost of working and diminished value of produce." He then proceeded to explain that the total amount of workable coal in this country was calculated to be about 80,000 million tons, which, allowing for the then rate of increase of 2¾ million tons per annum, would only last 212 years. He further states that "long before complete exhaustion takes place, England will have ceased to be a coal producing country on an extensive scale. The ultimate results will be to render labour so abundant in the United States, that our iron manufacturers will be underbid by the unrivalled iron and coal resources of Pennsylvania. The question is not, how long our coal will endure before complete exhaustion is effected? but how long will those particular coal seams last, which yield coal of a quality and at a price to enable this country to maintain her present supremacy in manufacturing?" Are we not already about to realise by experience what Lord Armstrong prophesied a third of a century ago? It is the case that many large collieries have already been closed because the expense of working prevented their competing, it is also the fact that foreign firms can already deliver in this country manufactured iron at lower prices than we can supply it notwithstanding their disadvantage in shipping rates. Within the past few weeks, for example, the Corporation of Glasgow itself obtained tenders for a large quantity of cast-iron pipes, when it was found that tenders from the United States were lower than any of their local firms.

In the year 1895 the stationary engines in Great Britain alone amounted to an aggregate of 2,200,000 H.P. Assuming that each H.P. requires as little as 5 lbs. of coal per hour, and that the average run is 10 hours per diem for 300 days per annum, the total coal used by stationary engines alone would amount to 15,000,000 of tons per annum; it is probably far greater than this judging from the general inefficiency and wastefulness of the existing engines. The author's main object is to localise the causes of this waste in the case of our important workshops and factories, and to discuss how this may best be obviated by the use of electricity.

Other objects which he has in view, however, are the attainment of the maximum output of machine tools, which can only be obtained by driving the tools at a steady maximum speed, and the greatest economy in labour, and otherwise in producing the driving power.

In the past there has been a tendency on the part of the trades unions to look upon one at least of the above objects as being opposed to the interests of the workman. American visitors quickly observe the slow speeds in our union-ridden shops. The late strike in the engineering trade has corrected this misconception as to the true interests of the workman, while it has put an end to the harrassing policy hitherto adopted by the trades unions which has so long delayed works improvements. The employer is henceforth free to control his own shops, and it is now left to him to make use of every available means of increasing and improving the output. If Great Britain is to continue in her present front position in manufacturing for the world, it behoves her leading employers to take prompt advantage of such improvements as tend in the above direction.

The methods of driving large works more generally in use may be divided into two classes:—

One that in which the power is transmitted by long steam pipes to engines scattered in different parts of the works. This results in loss by radiation and condensation from the pipes, and in loss attending the use of small engines. The other in which the transmission is from a large engine, by means of wasteful gearing and long lines of shafting and belting.

On the former system are arranged such works as shipyards, rolling mills, engineer's works, &c., where the net consumption of steam may be even 10 times that of an economical engine. On the latter system are works such as cotton mills, where the engine may be highly economical, and yet but 1 per cent. of the power may be applied to the cotton itself.

The advantages and economy obtained by substituting electric power in works using scattered engines are probably more distinct than in the case of works using a single large engine. One of these works alone will use as much energy as is demanded by an average provincial town for its electric lighting. The Bristol Waggon and Carriage Works, for example, use 710,000 H.P.-hours per annum, that is the equivalent of over 400,000 Board of Trade units of electric energy, and is considerably more than last year's electricity supply in such towns as Aberdeen, Belfast, Cardiff, or Dover.

The directions in which improvement may be looked for are chiefly the following:—

Saving of coal.
Saving of water and stores.
Saving of labour and attention.
Reduction of loss in shafting and gearing.
Increased output owing to steady speed of machinery.
Facility of extending by adding extra motors.

Saving of Coal.—Small scattered engines use as much steam per H.P.-hour as requires 6 to 10 lbs. of coal with an average boiler. An economical engine, on the other hand, should not use more than 1½ to 2 lbs. of coal. Tests published by Sir T. Richardson in a paper read before the North-East-Coast Institution of Engineers and Shipbuilders confirm this. At his own works there were 31 engines developing from 94 H.P. downwards, and using an average of 51 lbs. of steam per I.H.P.-hour, exclusive of losses in steam pipes. There were required to generate steam no less than eight main boilers and 23 auxiliary boilers. Electric power has since been adopted throughout these works, with the result that the whole of the main boilers and the majority of the auxiliaries have been replaced by a pair of marine boilers, while there is an actual saving of 100 tons of coal per week. At Messrs. Dorman & Long's, Middlesbro', six engines were replaced by electric motors, and as a result two Lancashire boilers were dispensed with, while there is a saving of 32 tons of coal per week. At the Bristol Waggon Works five Lancashire boilers are required for the present engines; with electric power plant one Lancashire boiler will suffice, and the saving in coal is estimated at 37 tons per week.

The loss of steam by condensation in pipes is most serious. Even with the best lagging the loss is considerable, while in most works where long pipes are used, the lagging is generally inferior, and frequently there is little or no lagging at all. Roughly speaking, every square foot of uncovered pipe-service, if continually under steam and exposed to the atmosphere, condenses as much steam as takes one-half ton of coal to generate; and with covering it may be from that to one-sixth of a ton. At Messrs. Richardson's the pipes varied in length up to 1,200 feet. At the Bristol Waggon Works there are 730 feet of pipe in use.

Saving of Water and Stores.—With small scattered engines it is generally impracticable to have satisfactory condensing arrangements; therefore the whole of the feed water is probably lost. With a common engine proper condensing arrangements may be made; and in any case there is a saving in water commensurate with the saving of coal above indicated. With a surface condenser and a cooling pond the water required may be as little as one-fortieth of that used by small separate engines. The stores, oil, &c., used by one common engine are, of course, less than those used by a number of engines.

Saving of Labour.—It is obvious that more men are required to attend to a number of engines than to one. It is equally apparent that a reduction in the coal consumption and in the number of boilers in use results in a saving of labour in firing.

Reduction of Loss in Shafting and Gearing.—The loss under this head varies greatly according to the conditions of each case. Prof. Kennedy stated in his address to the Institution of Mechanical Engineers in 1894 that for 100 H.P. of useful work it required 145 I.H.P. at the engine, that is to say, there was a loss of 45 H.P., of which, say, 13 H.P. would be lost in the engine, leaving 32 H.P., or 22 per cent. as the loss in the shafting. Mr. Crompton gives the loss in shafting as 32 per cent. Sir T. Richardson found the loss to vary from 25 per cent. to 70 per cent; the average was 43 per cent. At Messrs. Furness, Westgarth & Co.'s engine works, Middlesbrough, the loss in one shop, in which two long lines of shafting and a comparatively small number of tools were used, was 75·6 per cent. In two other shops it was 59 and 42 per cent; or about a general average of 50 per cent. for the whole works. In several different factories in Cleveland, Ohio, Mr. C. H. Benjamin found the loss to vary from 50 to 80 per cent. At the Bristol Waggon Works the loss varies from 22 to 57 per cent.; it is more often nearer to the latter figure.

With efficient electric power plant the losses apart from engine friction need not exceed for the dynamo 7 per cent., for the conductors 2 per cent., and for the motors 12 per cent., say, 20 per cent. in all, or, making an allowance for lower efficiency of the plant when loaded below the normal, say, 24 per cent in all. The loss in the conductors is proportional to the load, and is only a maximum when the load is a maximum, and similarly there is no loss in those motors which are out of use. On the other hand, the loss in the shafting is continuous whilst it is running, therefore the efficiency in those cases where machines are intermittently in use, that is the general condition, is considerably below the above figures. For example, if, say 50 H.P. is lost in the shafting continually and there is 50 H.P. in use for one half of the whole time, then in a day of 10 hours there would be 500 H.P.-hours lost in the shafting and 250 H.P.-hours used by the tools, so that out of 750 H.P.-hours, 66 per cent. are wasted in shafting. Frequently the hours of use are even less than half, so that the loss in such cases is still greater.

Increased Output.—It is most frequently to be found in the use of small scattered engines that the governing is defective, and the engines are so loaded that throwing on machines may seriously reduce the speed of the rest of the tools. With good self-regulating motors the speed is maintained constant for considerable excesses even of normal full load. As to the main engine, there is no difficulty in securing governing to practically constant speed; moreover, when large numbers of machines are operated by one main engine,

* Section G., September 12th.

there is less tendency, apart from the governing, to cause a fall in speed than is the case with a smaller engine running a less number of machines. At the Bristol Carriage and Waggon Works one of the existing engines pulls up to one-half its normal speed when the rack saw is thrown on. This, of course, seriously reduces the output of the whole of the tools driven off this engine, added to which there is the increased wear and tear of machinery and gearing, due to inconstancy of speed. Moreover, it is found with a constant speed that a higher speed may be adopted for the tools, which results in a still further output of work. At Messrs. Richardson's works, for example, where electric driving was adopted, the speed of the tools was increased by an average of 20 per cent., with a corresponding increase of output. In a rail rolling mill in the United States, where electric motors have been adopted, it is stated that the work hitherto done by 6,000 hands with separate engines, is now accomplished by 4,000 with electric power.

Facility of Extending.—As further machinery is added, the make-shift policy of altering the slide valve of the engine to cut off later is frequently adopted, regardless of the ensuing loss of steam. Electric power is vastly more flexible, it being the simplest matter to add an extra motor when further machinery is put down, so that little or no provision is necessary in the motors.

Method of Applying Motors.—At present, the first cost precludes the use of a separate motor to each machine, unless it be a large one. It is generally better to group a number of machines on to one motor, more especially if the load on the machines is variable. Very large powers should not be sent along one long line of shafting; it is better to use two or more motors in such a case. Variable machines should be more or less separated from machines where the load is steady, as it is desirable that in the case of a steady load the motor should be running continually at its most efficient load; whereas, if surplus power be required for a variable machine, then the motor would not run continually at its efficient load. For example, a large fan, which has a constant load, should not be grouped with a lift used intermittently on to one motor. In dealing with heavy work, portable tools driven by motors should be used to obviate the present expense and loss incurred in moving heavy castings from one tool to another. Several of these tools can work at one casting at the same time, thus considerably expediting the passage of heavy work through the shops. Heavy tools, such as lathes and large planers, may remain fixed, but drilling, slotting, shaping, milling, and cylinder-boring tools, should be made portable where work on heavy castings is concerned.

The Bristol Waggon and Carriage Works.

Description of the Old Steam-Power Plant.—There are five horizontal steam engines in all, varying from 100 to 10 I.H.P. Three of the engines are antiquated, having ordinary slide valves, and being controlled by a throttle valve operated by a slow-speed governor, while they are so overloaded that the valves are set to give steam practically the full length of the stroke. Two of the engines are modern, having variable expansion gear, while the slide valves are set to cut off and give a fair rate of expansion. Steam is generated in five Lancashire boilers placed in three different parts of the works, near the larger engines. The steam pipes, therefore, are not unduly long, with two exceptions, where the lengths are 158 feet and 112 feet respectively.

Water and Coal Consumption of the Old Plant.—The steam consumption is calculated from diagrams taken at various states of the load. An allowance was made for cylinder and port clearance, but no allowance for loss by leakage past the cylinder, nor for initial condensation in the cylinder, as the measurement of the steam was made near the exhaust end of the diagram. The re-evaporation which takes place during expansion, would cancel the initial condensation to some extent, though not materially so in all cases. It is impossible without actually weighing the steam used to say what deduction should be made for this loss. The following table sumarises the results of the different tests:—

Engine.	Pounds of steam per I.H.P.-hour.		
	Full load.	Normal load.	Light load.
1	41	46	58·7
2	40	44	47
3	70	96	96
4	34	33	48·5
5	35	32	32
Average	44	50	56·5

No. 3 engine, which is the most wasteful, is the smallest, the cylinder being 10 inches by 16 inches. It was found, by removing the cylinder cover, that there was an excessive leakage past the piston. If 25 per cent. be added for this and the condensation calculated in 158 feet of steam pipe, which connects it with the boiler, the steam per I.H.P.-hour would reach nearly 150 lbs.

The next most wasteful engine is the No. 1, whose cylinders are 18 inches by 30 inches, where the cut-off took place as late as about 80 per cent. of the stroke, while the loss of pressure in the steam pipe, owing to valves and bends, was 20 to 30 per cent. of boiler pressure.

No. 2 engine has also a very late cut-off, it being 83 per cent. of the stroke, and the loss of steam pressure between boiler and cylinder is 40 per cent. This engine is greatly overloaded. In fact, with heavy load the speed is reduced to one-half the normal, with a consequent loss of output.

Engines Nos. 4 and 5 are not exceptional in lack of efficiency, seeing that they use low pressure steam and are non-condensing. In the case of engine No. 4, however, there is a steam pipe 112 feet long of large diameter and uncovered for two-thirds of its length.

Losses in Steam Pipes.—There was no means of measuring the condensation, which was, therefore, determined by calculation, using a formula based on actual experiment. It has been found that the rate of transmission of heat through iron steam pipes is 3·5 British thermal units per hour per square foot of surface for each degree F. of difference in temperature between the steam and the surrounding atmosphere, and for indifferently lagged pipes with bare valves and flanges the coefficient may be 2·5. Taking the difference in temperature to be 300 − 50 = 250° F., and the time during which the pipes are in use as 3,000 hours per annum, each square foot of bare pipe would condense about 3,140 lbs. of steam, and of covered pipes about 2,250 lbs. of steam. The yearly loss by condensation in pipes would then be approximately:—

	Lbs. steam.
For 457 square feet of bare pipe × 3,140 = ...	1,440,000
For 277 square feet lagged pipe × 2,250 = ...	620,000
Total	2,060,000
Adding 25 per cent. for extra surface exposed in flanges, tees, valves, and fittings, and conduction through supports and otherwise	515,000
	2,575,000

Fuel Consumption.—The total fuel consumed per annum is approximately 2,500 tons, of which between 400 and 500 tons is waste wood, the value of which is about the same as that of coal.

The average load on the five engines is about 254 I.H P., and the time of working about 2,800 hours per annum. The energy used per annum is therefore about 710,000 I.H P.-hours, and as the normal steam consumption was found to be 50 lbs. per I.H.P.-hour, the total yearly steam consumption is ... ... 35,500,000 lbs.

To this add, say, 10 per cent. for leakage past piston and condensation in engines	3,550,000 „
Loss in steam pipes as above	2,575,000 „
	41,625,000 lbs.

This consumption of steam, divided by the weight of fuel, 2,500 tons, gives an average evaporation of rather less than 7·5 lbs. of water per pound of fuel. Two of the boilers are working under very unfavourable conditions, owing to the length of and restricted and tortuous nature of the flues, otherwise a better evaporative result would have been obtained.

The average consumption of fuel is 7 9 lbs. per I H.P.-hour.

Power Developed by Existing Engines.—A number of diagrams were taken off each engine, under various conditions, and from maximum to minimum load. The results of these are summarised in the table given at bottom of page. From this table are deducted the following averages:—

	I.H.P.	Per cent.
Total normal load	254	—
Loss in shafting	87·9	34·5
Loss in engine friction	45·4	17·8
Total loss	133·3	52 3
Power utilised by machines and their countershafting or gear	120·2	47 7

Table of Horse-power Used or Lost at the Bristol Waggon Works.

Number of engine.	Engine friction 85 per cent. of maximum.	Loss in shafting.	Total lost.	Percentage of power lost.	Used by tools and their countershafts.	Percentage of power used.	Light load.	Normal load.	Maximum load.	Power saved by dispensing with certain shafts and engine friction.
	H.P.	H.P.	H.P.	Per cent.	H.P.	Per cent.	H.P.	H.P.	H.P.	H.P.
1	15	21 7	36 7	37 3	61·7	52 7	76	98·4	103 7	25
2	7·5	27·2	34 7	73	12·8	27	40	47·5	100	21
3	2	4	6	75	2	25	6·4	8	11	2
4	6 2	11	17·2	54	14·5	46	25	31·7	42	6
5	14 7	24	38·7	57	29·2	43	60	67 9	97	22
Total ...	45·4	87 9	133 3	—	120·2	—	207·4	253·5	353·7	76

It will be seen on reference to the table that in the case of engines Nos. 2 and 3, the power lost in shafting and engine friction was no less than 73 to 75 per cent. In the case of No. 1 nearly half the power of the engine was utilised for driving three powerful fans placed close to the engine, which accounts for the somewhat smaller percentage of loss in the shafting. In the transmission of the remaining 60 per cent. of the power of this engine to the various fitting shop tools, fully 50 per cent. is lost. These results confirm those obtained by Sir T. Richardson, Mr. Westgarth, and Mr. Benjamin. They are, however, widely different from those published by Prof. Kennedy and Mr. Crompton. It may be noted that while the former are the results of actual test, the latter are presumably estimates.

Power required by various Tools.—There is comparatively little data published as to the power required for driving various tools; the author believes, therefore, that the following deductions made from the tests may prove useful:—

Large blowing fan for smithy	15 H.P.
Smaller " " " "	10 "
Large circular rack saw, cutting 2 feet log of English oak	20 "
Vertical frame saw, when cutting 22 inches × 20 inches pine, with 14 blades	14 "
Planing tool for wood	5 "
Foundry lift	2 "
Horizontal saw for wood	13 "
Circular saw " "	8 "
Small fan for foundry	5 "
75 miscellaneous tools in engineers' shop, comprising lathes, drills, slotting, shaping, and shearing machines, grindstones, and emery wheels, &c., of which about 41 were in use whilst indicating the engine	24 "

Power required for Electric Driving.—The power required by the various tools will be generally increased, owing to their greater output, but the power wasted in shafting and engine friction will be considerably reduced.

Instead of transmitting power from five engines, the shafting will be driven by 10 or more motors. These motors, owing to the small space which they occupy, are placed close to the point at which work is taken off the shafting. For both of these reasons considerable shafting is discarded. For example, in the case of engine No. 2 the normal load is 47 I.H.P., of which about 20 H.P. is lost in heavy underground gear and shafting, most of which is being dispensed with. The total power of the motors to do the present work is 76 H.P. less than that now indicated by the engines neglecting loss in transmission; that is, 254 − 76 = 178 H.P.

Coal, Water and Labour on the Electric System.—The new boiler will evaporate at least 9 lbs. of water per 1 lb. of coal, while the engine will, at working load, which is ⅝ths of full load, use 16 lbs. of steam per I.H.P.-hour. That is 1·8 lbs. of coal per I.H.P.-hour, or, say, 2 lbs. in all. Somewhat better results than this might have been obtained by the use of a more complicated plant, but it was decided that the extra first cost would barely compensate for the small additional saving.

It has been stated above that the motors will develop about 178 H.P. to do the present work. To this must be added the losses in the new transmitting system. The efficiencies may be taken as follows:—

Engine friction and ropes, say, ...	90 per cent.
Generator efficiency	92 "
Conductors	98 "
Motors, average	85 "
Total efficiency	69 "

Each H.P. at the motor pulley, therefore, requires 1·45 I.H.P. at the engine cylinder. The normal I.H.P. of the new engine will be about 178 × 1·45 = 258 I.H.P., which is within 2 per cent. of the power developed by the old engines.

Taking 2,800 hours of work per annum, there are, then, 725,000 I.H.P.-hours, which at 2 lbs. of coal per hour consume 650 tons of coal per annum. There is thus a saving of 2,500 − 650, say, 1,850 tons of fuel.

The water required on the new system will be about 10 per cent. of 16 lbs., say, 2 lbs. per I.H.P.-hour for making up the feed, and about 4 lbs. for making up that lost in the cooling apparatus, say, 6 lbs. of water per hour. So that the yearly consumption of water will be 435,000 gallons, or a saving of 4,162,500 − 435,000 = 3,727,500 gallons, a large part of which has been hitherto purchased from the town waterworks. In addition to this there will be a saving of oil and stores as well as of labour, inasmuch as there will be only one fireman in place of those at present required.

The total saving is approximately £1,000 per annum, quite apart from the other various advantages.

Reasons for Adopting the Three-Phase System.—Full consideration was given to the merits and demerits of the direct-current and three-phase systems, and the directors of the Bristol Waggon Works took the opportunity of seeing both systems in practical work under conditions analogous to those in their own works. The first cost of the two systems was approximately the same, while the following are the advantages of the three-phase system which appealed to the Bristol Waggon Works Company:—

1. The absence of commutators on both generator and motors, and the fact that the current passes direct through clamped terminals from the generator to the motors.

(It was noticed that the commutators of the direct-current motors and dynames were worn, and caused trouble, more especially in comparatively dirty workshops.)

2. The more mechanical design and construction of the generator and motors, the windings of the latter, being entirely enclosed by the iron frame of the machine, protecting them from accidental damage.

3. The fact that the three-phase motors can be left running for long periods without any attention, even when considerably overloaded, which is not advisable in the case of the direct-current motors.

4. The freedom from possibility of breakdown as compared with the direct-current system.

Brief Description of the Electric Plant.—Steam will be generated by one Lancashire boiler 28 feet × 7 feet 6 inches, fitted with a Bennis automatic stoker. The stoker is regulated by a piston in communication with the boiler, which throws the feed in or out of gear according to the steam pressure. The piston also operates a damper in the main flue, so that the pressure of the boiler is automatically maintained constant within 2 lbs. It is, therefore, only necessary for the fireman to fill the hopper with fuel and regulate the feed. A Green's fuel economiser will be inserted in the main flue, while there is provision made at the back of the boiler for the insertion of a superheater.

The engine, in order to provide for extension, is good for 400 I.H.P., and is of the horizontal compound type, having cylinders 13½ and 25 in diameter by 32 inches stroke placed on either side of the fly-wheel. The admission valves are on the Proell system with Corliss exhaust valves. The air pump, which is of the Edward's type, will be worked by a bell crank off the end of the L.P. piston rod. A centrifugal pump driven off the shafting will circulate the cooling water. A surface condenser with 650 square feet of cooling surface will be placed at a sufficient distance from the engine to admit of a filter for removing the oil before the exhaust passes to the condenser. As there is neither a natural supply of condensing water nor a cooling pond available, a cooling tower will be used for cooling the circulating water.

The generator, which is of the Brown-Boveri type, will be driven off the fly-wheel by ropes, while the adjacent fitting-shop shafting will be also so driven off the fly-wheel. The generater will absorb 275 B.H.P., and is provided with sliding foundations.

The main switchboard will consist of three panels, one being for the generator with a regulator for the exciter; another for the motors, each circuit having a triple switch and fuse, and ammeter; the third for the lighting circuit, with double switch and fuse on each circuit. The boards will consist of enamelled slate mounted on iron supports, so as to be entirely incombustible, no wood whatever being used.

There will be seven motor circuits, that is, one to each shop, each circuit being composed of three conductors. The number of motors at first will be 10, varying from 65 down to 2 H.P. The larger motors, viz, those of 65 and 50 H.P, will drive by ropes, the smaller motors by belts.

There will be about eight lighting circuits, one running to each department. They will consist of two wires only, one being the phase wire, the other being connected to a fourth or neutral wire, which is connected to the centre of the star winding. The voltage of the motors will be 190 and of the lighting circuits 110.

The lower voltage was adopted for the lighting circuits to enable the use of more efficient glow lamps, and to be at the same time more suitable for the arc lamps. There will be 750 glow and 32 arc lamps, which will give a better illumination at considerably less cost than the present gas lighting.

The whole of the conductors will be insulated with rubber, and run in hard wood casing throughout.

The generators and motors are being supplied by Messrs. T. Richardson & Sons, of Hartlepool, while the whole of the work is being carried out by the firm with which the author is associated.

INTERNATIONAL CONFERENCE ON TERRESTRIAL MAGNETISM AND ATMOSPHERIC ELECTRICITY.

ADDRESS BY PROF. A. W. RUCKER, M.A., D.Sc., Sec. R.S., President of the Conference. Delivered on 8th inst.

THE President of the Section of Mathematics and Physics has already expressed the pleasure with which British physicists welcome the distinguished band of visitors who have assembled to take part in the International Conference on Terrestrial Magnetism. None join in that welcome with more cordiality than those who are especially interested in the science with which the Conference will be occupied. To us it is a source both of gratification and pride that the International Committee, to whose action this meeting is due, should have allowed us to play the part of hosts to the eminent men from many lands who have responded to their call. Some whom we would gladly have seen here, but who have been prevented from attending by various causes, have nevertheless shown the interest which they take in our proceedings by sending written communications. Thus our meeting is as fully representative as we could have hoped.

It may be interesting to those who are unaware of the fact, if I remind the Conference that this is not the first occasion on which students of terrestrial magnetism have taken counsel together during a meeting of the British Association.

Fifty-four years ago the then President of the Association, the Very Rev. George Peacock, Dean of Ely, stated in his address that the period was drawing to an end for which a series of magnetic observatories had been established by international co-operation.

"Six observatories," he stated,* "were established, under the zealous direction of M. Kupffer, in different parts of the vast empire of Russia, the only country, let me add, which has established a permanent physical observatory. The American Government instituted three others, at Boston, Philadelphia, and Washington; two were established by the East India Company, at Simla and Singapore; from every part of Europe, and even from Algiers, offers of co-operation were made." The observations thus provided for were to be carried out for three years only, but as nearly the whole of that time was spent in preparation, the period was doubled. When the term thus fixed drew to an end, the question arose as to whether it was desirable to extend it further, and M. Kupffer (Director-General of the Russian System of Magnetic and Meteorological Observations) addressed a letter to Colonel (afterwards Sir Edward) Sabine, suggesting the propriety of summoning a Magnetic Congress to be held at the next meeting of the British Association.

In accordance with that suggestion, the Congress was held during the meeting of the Association at Cambridge in 1845. The number of distinguished foreigners who attended in person was considerable, in spite of the difficulties of travel 50 years ago. Amongst those who were present was M. Kupffer, Dr. Erman, of Berlin, the celebrated circumnavigator and meteorologist, Baron von Senftenberg, the founder of the Astronomical and Meteorological Observatory of Senftenberg in Bohemia, M. Kreil, the director of the Imperial Observatory at Prague, Dr. von Boguslawski, the director of the Royal Prussian Observatory at Breslau, Herr Dove, professor of physics in the University of Berlin, and Baron von Waltershausen, a gentleman who had taken part in the magnetic observations of Gauss and Weber at Göttingen, and had executed a magnetic survey of portions of Italy and Sicily. In addition to these a number of well-known British men of science were invited to be present, amongst whom I need only mention the Marquis of Northampton (President of the Royal Society), Sabine, Sir John Herschel, Lloyd, Airy, Brown, and Sir James Ross, then recently returned from his celebrated expedition to the Antarctic seas. Letters were also received from Wilhelm Weber, Gauss, Loomis, Lamont, Quetelet, A. von Humboldt, and others.

The principal question which this Conference had to decide was whether "the combined system of British and foreign co-operation for the investigation of magnetic and meteorological phenomena, which [had then] been five years in progress, must be broken up.†" I will not trouble you with a recapitulation of the recommendations of the Congress, some of which have been carried out, while others have not yet been realised; but one resolution will, I am sure, so exactly express your own sentiments, that I venture to quote it, viz: "That the cordial co-operation which has hitherto prevailed between the British and foreign magnetic and meteorological observatories having produced the most important results, and being considered by us as absolutely essential to the success of the great system of combined observation which has been undertaken, it is earnestly recommended that the same spirit of co-operation should continue to prevail." Whatever changes half a century may have wrought in the problems which press upon magneticians, and in the difficulties which confront them, there can be no doubt that they are still of the same spirit as that in which this resolution was framed.

It is true that we sometimes meet with the objection that international conferences of all kinds are now too numerous, and that their decisions from their very number and complexity cease to attract attention or to command respect. Admitting that this objection is not without weight, it may be answered by two remarks. The closer union between scientific workers in different countries which these meetings encourage, the strengthening of the ties of intellectual sympathy by those of personal friendship are in themselves good. It is surely a hopeful omen that science, as she reaches her maturity, forgets or ignores the political and geographical boundaries which sometimes seemed so important in her youth, and that workers for the common good are more and more learning that it is good to work in common.

But there are special and cogent reasons why the science of terrestrial magnetism should be cosmopolitan. The advance of some sciences is most easily achieved by the methods of guerilla warfare. In a hundred different laboratories widely separated workers plan independent attacks on Nature. In different universities and colleges little groups are devising stratagems and arranging ambuscades in the hope of wresting from our great opponent some of the treasures which she yields only to the violent who take them by force. But for those who would unravel the causes of the mysterious movements of the compass needle concerted action is essential. They cannot, indeed, dispense with individual initiative, or with the leadership of genius, but I think that all would agree that there is urgent need for more perfect organisation, for an authority which can decide not only what to do, but what to leave undone.

The advance of the science of terrestrial magnetism must depend upon the establishment, the maintenance, and the utilisation of the records of observatories. The bulk of the material to be dealt with must in any case be vast, and every needless addition to it, every obstacle in the way of its being readily comprehended and easily used, is a drawback which proper organisation should prevent.

Thus it is wasteful to devote to the multiplication of observatories, in regions of which we know much, energy and funds which would be invaluable if applied to districts of which we know little or nothing. I take some credit to myself in that within the last few months I have assisted in checking well-intended but mistaken proposals to add to the number of the magnetic observatories which we already possess in this country.

Again, it is desirable that the records of the observations should be so published as to be ready for application to the problems the solution of which they are intended to subserve, and that the individual worker should not be harassed by petty differences in the methods of presentment, which often entail on him labour too enormous to be faced. On this point something has already been done by international co-operation, and we may hope that this meeting will do much to complete the task.

Lastly, there are many investigations which are now undertaken independently at irregular intervals which would be far more useful if planned in common. Thus there has of late been a great outburst of energy in Europe devoted to magnetic surveys more detailed than have ever before been accomplished. Is it too much to hope that when the time comes for these to be repeated they may be carried out simultaneously, and reduced by the same methods, so that we may have a magnetic map of Europe in which no uncertainty as to the accuracy of details is introduced by the necessity for correcting for the secular change over long intervals of time?

Taking it, then, for granted that international co-operation is desirable for purposes such as these, I come next to the question of the nature of the machinery by which it shall be secured. And here I may at once state that the arrangements under which we are meeting to-day are in some respects abnormal, and that plans for the future will have to be formally or informally considered before we part. Meanwhile, it is desirable that I should state precisely the circumstances which have brought us together.

The last meeting of the International Meteorological Conference was held in Paris in September, 1896. It was attended by several men of science specially interested in terrestrial magnetism, and, perhaps on this account, a new departure was taken by the International Committee, in the appointment of a "Permanent Committee for Magnetism and Atmospheric Electricity," to which certain specific questions were referred. Eight gentlemen were nominated as members of this committee, with power to add to their number. We in turn co-opted eight other magneticians, taking care that as far as possible all countries in which terrestrial magnetism is specially studied should be represented. About the same time, and, as I believe, in ignorance of the establishment of this committee, a suggestion for the assembling of an International Conference on Terrestrial Magnetism was made in the *Journal* of that name by Prof. Arthur Schuster. It appeared to me and to Prof. Schuster himself that it would be a great pity if this suggestion resulted in the establishment of a rival organisation, and I at once submitted to the committee the question whether, in their opinion, it was desirable that we ourselves should take the responsibility of summoning an International meeting, with the view of obtaining a wide discussion of the points submitted to us by the Meteorological Conference. This suggestion was approved, and as the British Association was willing to allow us to organise the conference as a branch of Section A (mathematics and physics), to undertake the expense of sending out the necessary notices, to print our papers in its report, and to extend to foreign members of the conference all the privileges of foreign members of the Association, it was also determined that so hospitable an invitation should be accepted with the gratitude it deserved. But although the main result has been achieved, and a representative gathering of magneticians has assembled in Bristol, it cannot be denied that our relations to the various bodies with which we are connected are somewhat complicated, and that our constitution is devoid both of simplicity and symmetry. I take it that these facts are signs of health and vigour rather than symptoms of decay. Terrestrial magnetism has been attracting far more attention of late years than in the not very distant past. The necessity for meeting, for common action, for common publication has been forced upon us. We have cared more for meeting than for the terms on which we were to meet—more for acting together than for drawing up an elaborate deed of partnership—more for the promotion of science than for an orthodox paper constitution. Thus—and in my opinion most wisely—we have sought to attain our ends, not by starting a brand new International Association, but by making use of machinery which is already in existence, which has stood the test of time, and is, as I believe, capable of being put to new uses of meeting our wants and supplying our deficiencies.

I confess, however, that in this arrangement we have been compelled to pay scant attention to the simplicity and even to the logical consistency of our schemes. We are an international conference on special subjects—terrestrial magnetism and atmospheric electricity—summoned by a committee owing its authority and bound to report to another international conference of wider scope, which regards our sciences as branches of meteorology.

On the other hand, this Committee is for the moment a part of the Committee of the Section of Mathematics and Physics of the British Association, though it retains its right of separate meeting, more especially for the discussion of its report to the International Meteorological Conference. It is evident that here there is plenty of opportunity for collision between rival authorities, for confusion between conflicting jurisdictions; but to all questions as to the precise limits of authority and jurisdiction it is sufficient to reply in the most general terms. The whole of the arrangements are temporary, to meet an immediate pressing need. The work of the Conference will be conducted like that of a Department of the British Association. The members of the International Committee will act as the Committee of the Department, but some of their work will be done on the General Committee of Section A, of which other magneticians will also be members. Should it be necessary, they will hold some separate meetings, and some such meetings will certainly be necessary to discuss and then report to the International Meteorological Conference. These general regulations will probably suffice for all practical purposes. If cases occur which they do not cover, we must deal with them as they arise.

With regard to the future, I do not propose to lay before you any detailed scheme, but on discussing the matter among ourselves, the following principles should, in my opinion, be adhered to. The

* *Brit. Assoc. Rep.*, 1844, p. 44.
† *Brit. Assoc. Rep.*, 1845. p. 69.

International Meteorological Conference has held a number of successful meetings. I believe that I am right in saying that the right to attend the Conference was at first confined to those who were officially connected with meteorological and magnetic observatories, but that of late invitations have been more widely distributed. If the authorities of that Conference see their way to inviting in future most or all of those who are known to be specially interested in terrestrial magnetism, I do not see why the Magnetic Conference, which would then be constituted once in five years, should not meet all our requirements. If, however, additional meetings are necessary, I would urge that they should be held in turn in different countries, and, if possible, in connection with existing societies which play elsewhere the part taken by the British Association in this country.

That a permanent committee should be established is essential, and the mode of appointing this body must no doubt be considered, but I hope that in the course of the next few days the committee may be able to discuss the whole question, and that when the next meeting of the Meteorological Conference takes place we may be able to lay before the committee suggestions which may lead to the foundation of an International Magnetic Association on a stable and permanent basis.

Another matter of great importance is the maintenance of an international journal devoted to terrestrial magnetism. This we now possess, thanks to the energy of Dr. Bauer, and I feel sure that all present will agree that such a means of intercommunication is invaluable. I believe, however, that the enterprise is threatened with financial dangers, and I desire to take this opportunity of urging all those who are interested in its success to do what they can to support it by increasing the circulation. There is every reason for making more use of a common journal. The records of the observatories are necessarily so bulky, that anyone who desires to obtain the facts as to the magnetic state of the earth at any given time must collect or consult a large library of quarto volumes, in some of which the magnetic facts are mingled with data interesting chiefly to the meteorologist or astronomer. It is no doubt essential that an account of all the work done at each observatory should be published in a collected form, and that full details of the magnetic observations should be given; but for many, nay, for most, purposes, those who use the records will require only final results; the means of the various elements for the year, for each month, or for any other period which may hereafter be adopted, and the diurnal variation, are in general wanted, rather than the hourly values. If these means could be published together, once a year, an enormous boon would be conferred upon magneticians. For special purposes the theorist will have to test his views by reference to the results published in their fullest detail; but it would be no slight gain if the more salient facts could be compared by being placed side by side in the same journal. One advantage such a system would unquestionably possess; it would impress upon the authorities of the observatories the necessity for adhering to a common form of publication.

Some small beginnings have already been made. The Kew Observatory Committee now publish in the *Proceedings of the Royal Society* the annual means of the elements recorded by all the observatories which send their publications to Kew. By comparing two of these tables, the secular change can at once be determined. But the system is capable of extension, not merely to the normal values of the elements, but to disturbances. By common agreement Greenwich and Parc St. Maur publish in each year the records of the same magnetic storms. If this agreement could be extended, and if the facts thus selected were brought into juxtaposition, we might hope for a fuller and more instructive analysis than is at present usual.

Turning from questions of organisation, the primary business of our Conference will be to discuss four questions submitted to our Committee by the International Meteorological Conference.

The two first of these refer to the methods for calculating and publishing the monthly means of the magnetic elements which should, in our opinion, be adopted. I will not anticipate the discussion which will take place on these points, except to say that it will be necessary to bear in mind not only what is desirable but also what is practicable in view of the resources at the disposal of the directors of the various magnetic observatories.

Another question deals with the relative merits of long and short magnets, and on this point we shall have the advantage of hearing a report on the subject by M. Mascart.

Lastly, there is a very important proposal for the establishment of temporary magnetic observatories at certain specified places. General Rykatcheff and Prof. von Bezold present an important report on this subject, and I will only remind you, that whereas the accuracy and mathematical expression of the magnetic state of the earth's surface depend entirely on the number and position of the spots at which the magnetic elements are accurately known, the establishment of temporary observatories will be a costly undertaking, for the carrying out of which all the resources at the disposal of international science will have to be employed.

Another point of considerable practical importance will also be brought before us. The rapid extension of electrical railways and tramways is a serious menace to magnetic observatories. From all parts of the world we hear of observatories ruined or threatened by the invasion of the electrical engineer. Toronto and Washington have already succumbed, Potsdam, Parc St. Maur, Greenwich, and Kew are besieged, and the issue largely depends upon whether these great national observatories can or cannot make good their defence.

It seems to be a law of nature, ruling alike the human race and the humblest microbe, that the products of an organism are fatal to itself. The pessimist might infer that we are in presence of another instance of the universality of the application of this law, and that pure science is threatened by the very success of its practical applications. The smoke of our cities blots the stars from the vision of the astronomer, who, like the anchorites of old, flies from the world to mountains and desert places. It is only in the small hours of the morning when

> "Save pale recluse, for knowledge seeking,
> All mortal things to sleep are given,"

that the physicist can escape from the tremors of the traffic of a great town.

Civilisation as it spreads by aid of the means that science has placed at its disposal is destroying records and obliterating boundaries by the study of which the anthropologist and the biologist might have read far back into the history of our race. And now, in turn, the science of terrestrial magnetism, which, on the one hand, is forging another link to connect the sun and earth, and on the other, is penetrating within the surface of the globe to depths beyond the ken of the geologist, is threatened by the artificial earth currents of the electric railway.

That the crisis is serious there can be no doubt, but I will only anticipate the fuller discussion which will take place by stating that magneticians, in common with the rest of the world, recognise the great benefit which electric traction confers upon the community at large. We are not so foolish as to desire to embark on a crusade against a great industrial improvement of which science may well be proud; on the other hand, we must hold fast to the position that provision for the conveniences which are immediately appreciated by the public should be made with as little damage as possible to those studies which are not less for the ultimate benefit of the race.

Had science, when the use of coal was introduced, been sufficiently advanced to devise means for smokeless combustion, an evil, which now in more senses than one darken the lives of the inhabitants of our great towns, might have been prevented from attaining its present gigantic proportions.

We are now at the beginning of another industrial epoch, which may indeed, if power is transmitted from a distance on a large scale, brighten our skies, but which threatens to saturate the earth beneath us with electric currents. That these may interfere with the general comfort is evident from the injury which has been done to underground pipes at Washington and elsewhere. The construction of a powerful electrical railway in the immediate neighbourhood of the laboratories of a college would interfere with its efficiency, and make it impossible to perform experiments of certain types. In such a case, however, something could be done by arranging the experiments to suit the conditions under which they would have to be performed. But in the case of a magnetic observatory no such protective measures are possible. The very object of the observatory is to measure the earth's field, and if that field is artificially altered, no modification of the methods of measurement, however ingenious, can overcome this fundamental defect. I am glad to take this opportunity of acknowledging that both the danger to pure science and the necessity for obviating it have been acknowledged by those who are chiefly interested in the technical applications of science; and in particular that one of the principal technical journals, the *Electrician*, has supported the view that industry can and ought to respect the necessities of research.

If, however, there be any who are inclined to ask whether the careful study of terrestrial magnetism has led or is leading to any definite results, or whether we are not merely adding to the lumber of the world by piling up observations from which no deductions are drawn, we may answer that, though the fundamental secret of terrestrial magnetism is still undiscovered, the science is progressing. In the presence of several of the most active workers, I will not enter into a detailed discussion of the tasks to which they are devoting themselves; I will only ask that the doubter should compare a good summary of the state of the science of terrestrial magnetism written 15 or 20 years ago, such as that contained in the article by Balfour Stewart in the "Encyclopædia Britannica," with what would be written on the same subject to-day. Additions would have to be made to the descriptions of the instruments employed, to the discussion of the theory of the diurnal and secular change, while such questions as the reality of earth-air currents, and the tracing of loci of local disturbance have only been dealt with effectively in very recent times. When, too, we compare the older models of the magnetic state of the earth with that devised by Mr. Henry Wilde we cannot but admit not only that a great advance has been made in forming a simple diagram of the magnet state of the earth, but that it is probable that the model contains a very pregnant hint as to the physical construction of the earth as a magnetic body.

The fact that Mr. Wilde has imitated the declination and dip with remarkable accuracy all over the surface of the earth by means of a simple arrangement of electrical currents, and by coating the oceans with thin sheet-iron, has not attracted the attention it deserves. Whether the physical cause thus suggested be due to the greater depth to which the underground isothermals penetrate below oceans, the bottoms of which are always cold, or whether the geological nature of the rocks is different below the great depressions and elevations of the earth's surface, respectively may be open to question, but I am persuaded that the matter should be more fully investigated.

In conclusion, let me once more revert to the points on which I dwelt at the beginning of this brief address. We meet with the confidence of men who know that their science is progressing, but with the mingled hopes and fears of those who still have to deal with the great unsolved problem of the causes of terrestrial magnetism and of its manifold fluctuations. This solution will be most easily attained if we are not merely content to collect facts, but if we so arrange that they shall be easily dealt with. To observe is our first duty, to organise our second, and if these be fulfilled we may hope that a theory of terrestrial magnetism will in the future crown the efforts not merely of him on whom the first glimpse of the truth may

flash, but of the international co-operation which has, by way of preparation, made "the crooked straight and the rough places plain."

MUNICIPALITIES AS TRADERS.

By G. Pearson.

Read in Section F. September 12th.

In writing this paper I have felt that this meeting does not require from me a long explanation of my own municipal dogmas, but would prefer that I should review the present position of municipalities as traders, and the progress made in municipal trading, and I am inclined to think that that course will best serve as a peg on which to hang the discussion to-day.

We are long distant from the so-called "good old times," when it could be said "if each man swept his own doorstep, the village would be clean."

Individual performances of cleansing duties such as these, to say nothing of the still more important duty of sewage disposal, has long since ceased to be possible, and further, the days when citizens "paid their scot and bore their lot," have also long passed, and the performance of duties at the public expense which were formerly looked upon as the duties of the private individual has been accepted as reasonable and proper; and, proceeding one step further, the public provision of a water supply, and also of the supply of light; and, lastly, of a cheap, frequent, and regular mode of locomotion, has become so common as to cease to surprise, and now the suggestion of a dweller in any city providing his own separate system of cleansing, sewage disposal, water supply or light, would be regarded as a stupid waste of private energy.

Drainage was first recognised as a public duty forced on municipalities by the density of the population, to be followed by a public system of cleansing; but, at a comparatively recent date, a municipal water supply was looked upon as a first step in a downward course leading to the pit of socialism, but few, at the present time, regard it in this light.

The provision of light at a more recent date stood in the same position, but the advocates of the purchase of the gas and electric light undertakings form a majority in most of the municipal councils at the present time; but to-day the man who publicly advocates the provision of a tram system by a corporation is called "very advanced" in his views, to say the least, and by the older members of the corporation he would be looked upon as really a dangerous man, leading a confiding public to the abyss of municipal socialism. Personally, I have no dread of a name, and any scheme bearing on the face of it the impress of common sense would not be rejected by me because its opponents called it by a disagreeable title, and to hear a scheme in which I am interested called "socialistic" has no terrors for me.

Let us consider for one moment the growth of municipal trading, which will be best seen from the growth of municipal indebtedness, by means of which municipal trading has been rendered financially possible.

The loans to municipalities outstanding in the year 1875 amounted to £92,820,100. These outstanding loans had grown in the year 1895 to £235,335,049, an increase of £142,514,949, being an increase at the rate of 153 5 per cent. in the 20 years.

The National Debt was in the year 1875 £768,945,757, and it had decreased in the year 1895 to £656,998,941, or a decrease of £111,946,816 in the 20 years.

It will be seen from these figures that the increase of local indebtedness exceeds the decrease in the national indebtedness by £30,568,133. Local indebtedness represents loans due in respect of:—

Waterworks	£43,970,490
Harbours, piers, docks, and quays	32,777,992
Highways, street improvements, and turnpike roads	30,143,979
Sewage and sewage disposal	23,734,738
Schools	22,970,555
Gas works	16,931,943
Poor law purposes	7,773,504
Markets	5,775,076
Parks, pleasure grounds, commons, and open spaces	5,051,092
Public buildings...	4,958,954
Artisans' dwellings, improvements	4,351,532

There is also a long list of loans in respect of other public works, in respect of each of which a debt approaching £4,000,000 now exist, the list being too long for quotation here.

The figures I have read show the extent to which public funds have been used by local authorities in municipal trading. Taking gas, water, dock works, as three of the largest classes of municipal trading concerns, we find that the debt now existing (not the sum originally raised, which would, of course, be much larger, the present reduced figures being brought about by the operation of the sinking fund arrangement made in respect of each of these loans) shows the indebtedness at £93,680,425, being about £860,325 more than the total local indebtedness in the year 1875.

The foregoing figures show the great growth in municipal trading, by showing in some degree the growth of the municipal capital invested in it during the last 20 years, and these figures do not remain stationary. I have been unable to obtain the report of the Local Government Board for this year, but I have, by the courtesy of the secretary of the Local Government Board, obtained the figures of the national and local indebtedness for the year ending 1896. The National Debt has sunk to £648,474,143, as against £656,998,941 in the year 1895, a decrease of about £8,000,000 in the year, whilst the local indebtedness has grown to £243,209,862 as against £235,335,049 in the year 1895, being an increase of about the same amount.

The electric light figures are very instructive, and show the growth of municipal trading in electric current. Up to the year ending March, 1895, £1,378,818 only had been invested in these undertakings by local authorities, whilst I find from the Tables published in *Lightning* that 50 local authorities own their electrical undertakings, and from the figures there given, I estimate the capital invested up to the year ending March, 1897, at £4,000,000, and think by this time this sum must have grown to nearly £6,000,000.

Having shown the growth of municipal trading as evidenced by the growth of the capital account, let us consider for one moment the extent to which it may be extended to the advantage of the public.

I think that municipal trading should be confined to the provision of those necessities of civilisation which are so large as to be beyond the power of individual effort to supply and which do not form part of any Government department. The effort of the individual will generally produce more economically than either a company or local authority, but as between a company and a local authority there is, economically speaking, very little to choose, and corporations can claim to be free from the misappropriations of capital which appear to be incident to the formation of so many of the companies which from time to time come under our notice; and therefore the cheapness of the price of money when raised on the credit of a local authority as against the dearness of money when raised by a company must always enable a local authority to trade on a smaller gross profit than a company, and, therefore, requires less to be abstracted from the pocket of the consumers to secure success to the undertaking, whatever it may be. I am, therefore of opinion that the supply of water, gas, electrical energy, and trams should be in the hands of the local authority. Cleansing, ashing, and watering should also be done without the aid of a contractor, but I would not suggest, except under exceptional circumstances, that all municipal works, such as erection of buildings and other matters of that kind, should be undertaken by the municipality, but where for any reason whatever, and there are many reasons I know, there is a lack of outside competition, then these works can be done generally more economically and always better by the municipality than by a contractor.

There is another point which has to be considered, viz, the formation of "rings" and "trusts" formed with the object of keeping up prices to artificial levels. The only way to meet combinations such as these is for local authorities to face the position and do the work themselves.

On the other side of this question is to be found the question of labour. Local authorities popularly elected are liable to pressure from without, to which the directors of public companies and private individuals are relatively free.

Working men have votes, and will use them to serve their own ends, precisely to the same extent as other people, and labour questions raised just before a November election put the independence of a candidate for a seat in the Council to a severe test; but this, in my opinion, is a "nettle to be grasped" by a straight refusal on the part of the candidate. It is seldom when this is done that the labour combination is successful.

I cannot claim a very long experience in the management of large bodies of men, having only had a few years experience as a member of the Sanitary Committee of Bristol. This Department pays about £2,000 per week in wages, but the experience I have had as a member of that committee shows me that a position of absolute neutrality in respect of all trade combinations, and the acceptance of the services of any competent workman, whether unionist or not, extorts a respect even from those who may be violent partisans either on the one side or the other.

There remains one other enterprise which appears likely to be placed within the reach of any enterprising municipality. I refer to the "telephone." The recent report appears to contemplate municipalities undertaking this work. Personally, I would rather be without it. I have no more faith in a municipal telephone than a municipal telegraph or municipal post office. In my opinion, telephonic communication should be provided by the Imperial Government and not by the municipalities. If this is done, we can do without the competition in telephone supply, of which we have lately heard so much, and the sooner the better this is done. If it is long delayed it will have developed into a large undertaking with a large goodwill built upon the basis of the grants made by municipalities of the use of the public street at a nominal cost, or, perhaps, at no cost at all to the company. If we are to have the nuisance of underground telephone wires, and the still greater nuisance of overhead wires, the quicker the better it will be for the Government to secure from that nuisance some profit for the public who have to submit to it. The longer the present companies live the tighter will they fix themselves on the public shoulders, and the more expensive it will be to remove them, as removed they must be sooner or later at any costs.

There is one other question now being prominently raised, and it is discussed in the recently-issued report of the Telephone Committee, viz, ought municipalities to trade for a profit. In my opinion they ought. Speaking as a municipal man, I should have very little inducement to trade at all but for the hope of success with its usual accompaniment profit. Birmingham trades, Manchester and other towns trade, at a profit, and I fail to see why they should not—subject only to the condition that they do so on the same lines as ordinary individuals and companies, and that they do not secure a profit by charging at a rate higher than would be charged by a company. Take the case of Bristol as an example, and I think ours is a fair sample of the average of cases of the kind. We have in Bristol 60,000 ratepayers, and under 1,000 users of the electric light. The luxury of private lighting to the few is rendered possible by pledg-

ing the credit of the many, and why should not the many reap some benefit from the risk they run, to say nothing of the actual loss which attended the early years of our undertaking, which was paid out of the rates levied upon them. I think Parliament will be wise not to put such restriction as to profit making as are shadowed forth by the report of the Telephone Committee. They may well leave the question of the amount of the profit to be settled by the natural law of supply and demand. The moment a municipality charges more for an article than it is worth will be the moment the public will refuse it.

If we review the result of municipal trading, I think its advocates (of which I am one) have little to fear. Birmingham, Manchester, Glasgow, and other large towns have shown a very good lead, which it remains for others only to follow. Failures are very seldom reported, and, having regard to the "fierce light" which surrounds all municipal trading, I think the fact that few failures are reported is caused by the fact that there are few failures to report.

There is one other risk which it is impossible to omit to notice. There may be dishonesty in the official, or, still worse, there may be dishonesty in the council, but I think the risk is small in each case. So far as officials are concerned, business-like regulation may be made which, if powerless to actually prevent fraud, will most assuredly detect it, and I think the personal character and position of the members of the various representative bodies, coupled with the fact that more than one or two must be "in it" to secure success, will prevent any serious malpractices by the representatives, even if they were so minded.

COMPARISON BETWEEN CHARGING A SECONDARY CELL AT CONSTANT POTENTIAL AND AT CONSTANT CURRENT, MORE ESPECIALLY AS REGARDS EFFICIENCY.

By A. A. Cahen and J. M. Donaldson.

(*Read in Section A, September 8th*, 1898.)

The method of charging secondary cells at constant potential has only comparatively recently come into vogue, and the probable reason for its adoption now is the saving of time thereby effected.

Little, however, is known, and nothing, as far as we are aware, has been published with regard to the efficiency and physical characteristics of the method.

The following tests were carried out to investigate these matters, and in order to make a fair comparison between charging at constant potential and charging at constant current, a complete set of experiments by each method was tried on one cell.

This cell was of the Tudor type, and had two positive plates (pasted) and three negative plates (unpasted). The size was that called 11 L A, and its listed capacity, charging at 20 amperes and discharging at 36, was 108 ampere-hours.

In order to get the true or working efficiency of the cell, it was charged and discharged many times without intermission, until charge and discharge curves, obtained in consecutive experiments, did not appreciably differ.

On February 24th, 1898, charging at constant potential was begun, and in all 50 charges and discharges were carried out, the intervals between charge and discharge, discharge and charge being, on an average, one minute.

During the charge the potential difference between the terminals of the cell was kept constant at 2·51 volts, and charging was continued until the current had fallen to 10 amperes.

During the discharge the current was kept constant at 36 amperes, and the discharge was stopped when the P.D. had fallen to 1·82 volt.

The last charge was given on March 4th, and on March 7th, after a preliminary discharge, charging at constant current was started.

The cell was charged at a constant current of 20 amperes, and charging was continued in the first 22 tests until the P.D. had risen to 2·51 volts. During the twenty-third and following charges this limit was increased to 2·58 volts, in order to increase, if possible, the capacity, which was low in comparison with that obtained after a charge at constant P.D.

Discharge took place at a constant current of 36 amperes and was stopped when the P.D. had fallen to 1·82 volt.

Forty-six charges and discharges were carried out.

As, however, the capacity of the cell when charged at constant current was considerably less than that after a constant P.D. charge, we suspected that the heavy currents passed through the cell during the charges at constant P.D. had injured it, and so this method was again started to see if the capacity was still the same.

This was on March 17th, after an interval of only half-an-hour.

Seven charges and discharges were sufficient to show that the capacity had not diminished, and these experiments brought the tests to an end.

Results Obtained by Charging at Constant P.D.

Capacity and Efficiency.—The curves of charge and discharge drawn from the results of experiments 37—46 inclusive lie very near together, and the mean of the results was used in calculating the working efficiency.

The means of the results of experiments 13—49 inclusive, which do not differ much from the above, are also given.

The mean capacity and efficiencies from tests 6 and 7 of the second series of constant P.D. tests are also given, and it will be noticed that the energy efficiency is somewhat less than in first series.

Experiments.	Ampere hours put in.	Watt hours put in.	Ampere hours taken out.	Watt hours taken out.	Quantity efficiency per cent.	Energy efficiency per cent.
1st Series—						
Mean of 37—46	91·89	230·4	86 07	163·5	93 7	71
„ 13—49	91·97	230 7	85 99	163·2	93 5	70 8
2nd Series—						
Mean of 6 & 7	93·60	235	85·2	161·0	91·0	68·5

The *density* of the acid varied from 1·159—1·175 in the first series of tests, and from 1·154—1·174 in the second series of tests.

"Gassing," or the brisk evolution of hydrogen bubbles from the negative plates, occurred just after the first rapid fall of current was over—this was when about two-thirds of the charging time had elapsed.

Resistance.—Only approximate figures can be given, as no special arrangements were made for taking the E.M.F. accurately at the moment of making or breaking the circuit.

During the last few tests of the second series the resistances were as below:—

Beginning of charge.	End of charge.	Beginning of discharge.	End of discharge.
0·0033 ohm.	0·01 ohm.	0·0043 ohm.	0 0033 ohm.

Shape of Curves.

Charging.—At the beginning of the charge the currents are, of course, very large, about 170 amperes being the usual initial current.

During the first three minutes of the charge a curious phenomenon always took place. The current fell by about 10 or 20 amperes, and then rose again very rapidly. After remaining fairly constant for about three minutes, the current falls very rapidly to about 40 amperes, and then drops much more gradually, becoming nearly constant at 10 amperes at the end of the charge.

This initial falling and rising again of the current we considered to be due to an excessive liberation of hydrogen by the large currents, causing a temporary increase in the back E.M.F. of the cell.

It did not occur in the first few experiments of the second series of tests at constant P.D., but appeared to a lesser extent in the last. The curves in these tests showed a steady falling off of current throughout.

Discharging.—The P.D. shows a very rapid initial drop, after which the curve bends off nearly at right angles, and then keeps quite level for a considerable time. After this the P.D. falls at an increasingly rapid rate. After a charge at constant current, the P.D. falls rapidly at first, and the change to the nearly level portion is not abrupt.

In the first case—*i e*, after a constant P.D. charge—the rapid fall is practically over in the first three minutes, and after this the curve is nearly level; whereas in the other case the initial drop lasts three or four times as long, and the curve afterwards shows a gradual fall.

Charging at Constant Current.

By this method we obtained considerably smaller capacities, but higher efficiencies.

The working efficiency was obtained from the results given by experiments 44 and 45.

The mean of experiments 23—45 is also given.

Experiments.	Ampere hours put in.	Watt hours put in.	Ampere hours taken out.	Watt hours taken out	Quantity efficiency per cent.	Energy efficiency per cent.
44 and 55	68 35	152·1	65 25	123·1	95·4	81·0
23—45	...	...	...	...	95 1	81 0

The *density* varied from 1·155—1·167, a less range than when charging at constant P.D.

Resistances.—

Beginning of charge.	End of charge.	Beginning of discharge.	End of discharge.
0·0038 ohm.	0·0077 ohm.	0 0041 ohm.	0·0034 ohm.

The shapes of the curves of charge and discharge at constant current are very well known, and need not be commented upon here.

Comparison of the Two Methods of Charging.

What we have to compare in order to get an insight into the relative advantages and disadvantages of the two methods are:—

1. The *discharge capacity*, or the energy we can get out of the cell.
2. The time *needed for charging*.
3. *The storage efficiency* or ratio of $\frac{\text{watts taken out}}{\text{watts put in}}$.
4. *The life of the cell.*

The first three are put into tabular form below, and we thus see that by charging at constant potential the time of charging is less than half that which is required if we charge at constant current, and that the capacity is 30 per cent. greater if the first method is employed, but that the energy efficiency is 10 per cent. less.

This loss of efficiency is probably due to the excessive heating caused by the large initial currents.

With regard to the life of the cell when charged at constant P.D., we can only say that, after more than 50 charges and discharges, the cell seemed in no way the worse.

The plates were not at all bent, neither was the amount of sediment at the bottom of the cell notably greater than at the beginning of the tests.

Method of charging.	Time of charging, minutes.	Capacity.		Efficiencies.	
		Ampere-hrs. taken out.	Watt-hrs. taken out.	Quantity per cent.	Energy per cent.
Charging at constant P.D. 2·51 volts. Charge till current = 10 amperes. Discharge at 36 amperes till P.D. 1·82 volt.	82	86	163	93½	70¾
Charging at constant current 20 amperes till P.D. = 2·58 volts. Discharge at 36 amperes till P.D. 1·82 volt.	206	65·2	123	95½	81

ALUMINIUM AS AN ELECTRODE IN CELLS FOR DIRECT AND ALTERNATE CURRENTS.*

By E. WILSON.

(*Continued from page* 373.)

Another set of experiments was made with two cells having as electrolytes a 5 per cent. solution of H_2SO_4 in water, and a saturated solution of potash alum in water. The area of the pure aluminium plate exposed to the fluid was 17 square inches in each cell. A current of 1 ampere was passed for four hours through the H_2SO_4 solution cell, and three hours through the other. At the end of these times the temperatures were respectively 33 and 51° C. With the 1 ampere passing from Al to C, the potentials between the plates were respectively 6·3 and 20 volts. The cell containing the plate formed in potash alum solution was then heated, the current through it being kept fairly constant by means of a considerable external resistance and 110 volts. It was then cooled by placing it in a freezing mixture of ether and carbonic acid snow. The temperature in this case was reduced somewhat rapidly, and a portion of the electrolyte at the bottom was frozen, probably a cryohydrate, leaving liquid above. The temperature of this liquid portion did not fall below zero centigrade. The results are given in Table IIIa. When

Table IIIa.

Time.	Amperes.	Volts across one cell.	Temperature.	Remarks.
			Heating.	
			°C.	
12 45 p.m.	0·154	28 8	17	Al connected to positive pole of charging cells.
1.0 „	0 154	27·0	18	
3.40 „	0·174	15·3	24	
4.20 „	0·170	16 2	25	
6.40 „	0 187	16·6	26 5	
			Cooling	
11.0 a.m.	0·161	29·2	13	The temperatures are those of the liquid electrolyte.
11.3 „	0 160	30·1	11	
11.35 „	0·158	30 8	3	
12.0 noon.	0·160	31 0	1	
12.30 p.m.	0 168	26 3	2	Bottom portion of electrolyte found frozen.
1 0 „	0 170	25 2	2	
1.10 „	0 055	4 95	2	
1.12 „	0 058	1·35	2	Al to negative.
1.14 „	0 235	2·25	2	„ „
1.15 „	0 165	26 6	2	Al to positive.
2.50 „	0 158	31·2	not known	Fluid portion of electrolyte poured away, only frozen portion remaining.

comparing these with the results of Table III., one must remember that the areas of the plates in the electrolyte are 17 square inches in Table IIIa. and 8½ square inches in Table III. This paper does not deal with the chemistry of the effect discussed. It is known that a clean aluminium plate acquires this film when simply submerged in alum solution, in the presence of oxygen without the passage of currents. We have seen that with a given film time is required to develop the effect.

* Communicated to the Royal Society by the late Dr. J. Hopkinson, F.R.S. Received May 11th; read May 26th, 1898.

Note Added May 19th, 1898.

[The film on these plates has been examined by Mr. Herbert Jackson, of the Chemical Department, King's College, London, and the following is his communication:—

"King's College, London,
"*May 12th*, 1898.

"Dear Wilson,

"I waited to send you the results of my examination of the aluminium plates until I had looked at them carefully with the microscope. Not much information, however, is to be gained from this. The skin over the plates is, however, seen to be full of minute cracks in every direction giving the impression of a dried gelatinous pellicle; not an unexpected appearance if the plate had been covered when wet with a thin coating of the gelatinous aluminium hydroxide. The analysis of the film over the metal shows it to consist of basic aluminium sulphate. The origin of this may of course have been the formation in the first place of aluminium hydroxide which subsequently reacted with some of the alum solution to give the basic compound. How far the formation of this may have anything to do with electrolysis would, I should think, be difficult to say without further and more elaborate experiment, and it must be remembered that a similar coating can be obtained on an aluminium plate by immersing it in an alum solution and leaving this freely exposed to the air.

"Yours sincerely,
"Herbert Jackson."

I have tried an experiment which I think shows that a film formed on aluminium by first being placed in contact with an alum solution and then exposed to the air, gives the same effect as a film formed in the cell when a current is passed from the aluminium to a carbon plate through the electrolyte. Two similar bright aluminium plates were prepared with carbon plates on either side of them, the area of aluminium in the electrolyte being 8½ square inches. The electrolyte consisted of a saturated solution of potash alum in water. One plate was left in the solution for seven hours with no current passing, and then exposed to the air for 16¾ hours. The other plate was submerged in the fluid and immediately readings were taken of the current passing and potential difference in volts between the aluminium and carbon plates. The effect in this case was exactly what was previously observed. That is to say, the current being maintained constant at 0·055 ampere by about 2,000 ohms being inserted in circuit with the cell across about 110 volts, the potential difference immediately passed from a small negative value through zero, and after 3 minutes and 40 minutes had respectively the values 1·8 and 2·27 volts; the temperatures being 12½ and 15½° C. The test was continued. For the next 5½ hours the current was 0·204 ampere, it was then dropped to 0 055 ampere and kept at this value for 16½ hours. At the end of this time the potential was 10 volts with 0·55 ampere, and 28·6 volts with 0·163 ampere, the temperature being 15° C.

The other plate was submerged in its solution, the potential difference and current being immediately noted as before. The results in this case show that the potential, with 0·054 ampere, rose immediately from a small negative value of about 0·2 volt to a positive value of 1·8 volt. After 4 minutes and 40 minutes respectively the potential with current 0·054 had the values 2·07 and 2·56 volts, the temperatures being 13 and 15·5° C. This, I think, shows that a film formed by exposure to the air after being submerged in a saturated alum solution, has the same effect as another formed in this electrolyte during the passage of current. This test was continued. After 24 hours, during which the current was 0·0523 ampere, the potential was 11 volts, with this current passing, and the temperature 16° C.

The two cells were then placed in series and an average current of 0·048 ampere passed through them from the aluminium to carbon plates for 50 hours. At the end of this time, with current 0·048 ampere, the potentials were 10 in the case of the plate partially formed without current, and 10·3 in the case of the other; the temperatures being 19 and 17½° C. respectively. With current 0·121 ampere, the potentials were 26·2 and 27·4 respectively at temperatures 21 and 19½° C.]

Sodium hydrate forming a weak solution in water was tried as an electrolyte, the area of the Al plate being the same as before, 17 square inches. The forming current of ·8 ampere was passed from Al to C for 2 hours, 20 minutes, when the potential between the plates was 13·6 volts, the aluminium plate being covered with a thick black deposit.

Part II.

Alternate Currents.

The experiments with alternate currents were undertaken in order to investigate the instantaneous values of potential and current. One object was to see if the effect we have dealt with in the first part of this paper has time to properly develop with ordinary frequencies, and, if so, under what conditions. Another object was to see if aluminium is a valuable metal for use in condensers for alternate currents.

Aluminium-Carbon Cells.

If the time taken to develop the effects dealt with in the first part of this paper were very small compared to the time of a complete

period of an alternating potential applied to the cell, one would expect to get a practically uni-directional current in the circuit of the cell under favourable conditions as to temperature and applied potential. This is not the case with the cells and frequencies dealt with in this paper. In all these experiments the author has endeavoured to make the cells the controlling part of the circuit, that is to say, between the terminals of the alternate current machine a small non-inductive resistance and a Siemens dynamometer were the only part of the circuit other than the cells experimented upon. The copper resistance of the circuit including armature was from 1 to 5 ohms.

In the first portion of these experiments, the results of which are given in Table IV., the instantaneous values of the current, and the

TABLE IV.

Experiment.	Frequency.	First half period.			Second half period.			Ratio of maximum coulombs.	Average watts per period.	Amperes given by Siemens dynamometer.	Average temperature of cell C.
		Maximum volts.	Maximum amperes.	Phase difference 360° = one period.	Maximum volts.	Maximum amperes.	Phase difference 360° = one period.				
(1)	92	8·9	5·2	24°	26	4·0	56°	1·35	26·8	3·28	27
(2)	91	7·8	1·6	57	8·9	1·5	69	1·07	2·65	1·10	9
(3)	91	14·2	16·2	6	33	9·9	42	1·97	120	8·99	26
(4)	74·5	21·1	39·8	3	18·6	26·5	3	1·78	294	21·0	36
(5)	52	13·4	14·5	6	20·2	9·6	24	1·54	86	8·16	35

potential difference between the terminals of the cell, were observed by aid of a Kelvin quadrant electrometer and a revolving contact maker. The cell across which the potentials were observed consisted of one aluminium plate, $\frac{1}{16}$th inch thick, separated by $\frac{1}{4}$th inch from a carbon plate $\frac{1}{4}$ inch thick, the electrolyte being a saturated solution of potash alum in water. The surfaces thus opposed to one another in this electrolyte have each an area of 36 square inches. Another cell of the same size as the above was placed in series with this cell. Four smaller cells were used in some of the experiments, as will be set forth. Each of these consists of a thin aluminium plate opposed to a carbon plate, the opposed surfaces in a saturated solution of alum have each 8 square inches area, the distance between such surfaces being $\frac{3}{4}$ inch.

In Table IV. the arrangement of these cells was as follows:—Experiments (1) and (2), all the six cells in series. Experiment (3), the two large cells in series with one another, and with the four small cells arranged 2 series 2 parallel. Experiments (4) and (5), only the two large cells in series were used. No attempt was made to cool or circulate the electrolyte, but it had considerable volume and took some time to heat and cool. In all cases there was an excess of salt to insure saturation. Table IV. contains the important information obtained from the tests.

These figures show that small currents are accompanied by large phase difference, but the effect we are looking for, namely, a large ratio between the maximum coulombs in the two halves of a period, mainly develops with large currents for a given frequency accompanied by high temperature and small phase difference. The average watts have been deduced from the product of instantaneous volts and amperes at 20 equal intervals during a period.

(*To be continued.*)

BELT DRIVING.

II.*

THE making of pulleys from thin sheet steel with all sorts of hollows and irregularities in the rim is properly condemned. Pulleys ought also to be made to standard forms. High convexity is an error; a belt ought to bed over its full width. A 30-inch belt on a convexity of $\frac{5}{8}$ths or $\frac{3}{4}$ will only do the work done by an 18-inch belt on the same pulleys properly crowned.

A double belt on a $\frac{1}{4}$-inch crown loses 3 per cent. at 1,500 feet velocity, the loss increasing to 20 per cent. on a $\frac{3}{4}$-inch crown. At 2,000 feet velocity the loss increases to from 5 to 25 per cent., and at 4,500 feet velocity the loss is from 35 per cent. to 55 per cent. A Lancashire firm, advised by the author, went into the matter thoroughly, and finally reduced the crowning of a 24-inch wide pulley from $\frac{3}{4}$ inch to $\frac{3}{16}$ths inch. A crown of $\frac{1}{16}$th is sufficient for pulleys up to 6 inches wide, and for pulleys over this width $\frac{3}{32}$ inch. On vertical shafts the convexity may be doubled. The driven pulley may be flat. Of course, a really true running belt only needs flat faced pulleys, and we ourselves would say, use the minimum possible crowning. If a belt is straight and true, and shafts truly parallel, a very slight convexity will keep a belt to its place. Pulleys are recommended to be as large as there is room for.

Jockey pulleys are costly expedients in power, as well as very destructive on belts. By abolishing the jockey and compounding the belt instead, there will be a gain of 70 per cent. of power. Flanged pulleys also are destructive and useless agents. If they must be used, employ link belts, the rivet heads of which will run on the flange and not endeavour to *climb*. But no flanges are really needed, even on vertical shaft pulleys which ought to be double the width of the belt to give room for the belt to play without coming off.

By taking out numerous small engines and using long compound belts instead, a Ramsbottom bleach works saves 340 tons per month of coal. Twenty-eight small engines have been removed and 20 tons of steam pipe has been scrapped. Speaking of ropes the author recommends the square leather rope which is less wasteful of power than round ropes; but ropes do not run so economically as do belts. This is so. Ropes are claimed to require less width for main driving, but this is denied. The system of compound belts enables belting to transmit more power per inch of breadth than can be got from ropes. Ropes, of course, though thick, have only three-fourths the area of square ropes, and there is great loss of breadth between groove and groove. Our own experience as regards toothed gears, belts, and ropes, arrived at some years ago, was that where an engine would indicate 100 H.P. in gears, it would drive the same machinery by belts and indicate 105, and by ropes and indicate 110. These figures still fairly represent the loss of power by ropes and belts, but Mr. Tullis claims for belts results equal to best gearing with less risk of breakdowns. He condemns belts working side by side as being like ropes—not really working evenly together. But superposed, each belt does its proper duty. Side by side the shorter of two belts does the maximum work.

Several varieties of belt are briefly described, and their special points eulogised, but the general conclusion is that leather is all round the best belting material. Nothing like leather is still the cry. Mr. Tullis's paper is, briefly stated, a special plea for the trial of compound belts. The moral is, that if your load increases do not spend money unnecessarily in changing pulleys, but put a fresh belt on top of the old one. If a belt wears out quickly, put on a new one with the old belt on top of it. Does a belt slip, then compound it? He makes a good case. Yet how rarely is a compound belt to be found. Mr. Tullis makes out a very good case for them, and they may with advantage be used in all cases where existing belts are found insufficient to perform their duty without slipping.

* First article June 3rd, 1898.

CYLINDER RATIOS.

IN a recent paper before the North-East Coast Institute of Engineers and Shipbuilders, Mr. James Andrews endeavours to place the subject of determining cylinder ratios upon a systematic basis. The relative volume of cylinders has always been a subject of much study. Some engineers aim at securing an even distribution of power between the various cylinders of a multi-cylinder engine. Others again seek to so arrange the cylinders that the range of temperature shall be alike in each, while others again would aim at securing that the ratio $\frac{t}{t_1}$ should be alike in each cylinder, t and t_1 being respectively the initial and final absolute temperature in each cylinder respectively. The author does not pretend that any rule of proportioning will give great exactitude in results because of the disturbing effects of crank positions and receiver capacities, &c.

The author submits that a better understanding of the question would be attained if changes of leading dimensions of an engine were made as nearly relative as possible, thus facilitating improvements being made with confidence. In designing multi-cylinder engines certain conditions must be determined at the outset as a basis, and the following are laid down as desirable:—

(*a*) Maximum load on each piston.
(*b*) Temperature range in each cylinder.
(*c*) Indicated H.P. in each cylinder.
(*d*) Rate of expansion in each cylinder.

All the above should be approximately equal.

By securing equality under (*a*) will be secured the greatest maximum power with the least weight and smallest first cost.

Under (*b*) the author thinks equality in each cylinder is essential to best economy.

As regards (*c*) while equality of power does not appear to have a direct influence on economy, yet sea-going engineers aim at securing equal powers per cylinder, and as they have the arrangement of the working conditions of the engines, the designer must recognise the fad, if it be one, and so arrange matters that in securing equal powers the engines are not otherwise rendered uneconomical. There is, also, no evidence to show that equal powers are other than good for economy. As regards (*d*) equal cut-off is desirable to keep initial volumes and surfaces relatively equal in each cylinder.

Taking the case of the two-cylinder compound, the various factors are:—

P_1 = mean initial absolute pressure.
P_2 = mean receiver absolute pressure.
P_3 = mean back absolute pressure.
M P = mean pressure reduced to low pressure cylinder.
M P_1 and M P_2 = mean pressures in high pressure and low pressure cylinders respectively.
B_1 and B_2 = relative cylinder volumes.
r = ratio of expansion.
r_1 and r_2 = rate of expansion in high pressure and low pressure cylinders respectively.
D fraction of drop area relative to whole combined diagram.

Saturated steam having the expansion curve P v $^{1.0}$ = constant, the question is stated on the basis of equal powers and equal expansions

per cylinder. Given these equalities we are to find the cylinder ratios thus:—

$$M P = \left[P_1 \left(\frac{10}{r} - \frac{9}{r^{\frac{10}{9}}} \right) - P_3 \right] (1 - D).$$

$$M P_2 = \frac{M P}{2}; \quad P_2 = \frac{M P_2 + P_3}{\left(\frac{10}{r^2} - \frac{9}{r_2^{\frac{10}{9}}} \right)}$$

$$M P_1 = P_1 \left(\frac{10}{r_1} - \frac{9}{r_1^{\frac{10}{9}}} \right) - P_2.$$

$$R_2 = \left(\frac{P_1}{P_2} \right)^{-9}$$

When $R_2 \times r_1 = r$ and $M P_1 = M P_2 \times R_2$ the ratio of the cylinders will be correct as required; but a variation of r or of $(1 - D)$ or of both these, may be required. To eliminate $- D$ without allowance for the free heat added to the receiver is slightly incorrect, but the variation of "drop" involves so many other variations that its effect is difficult to allow, and variable quantities have been left out of the question to avoid complication. Most irregularities can be usually corrected by link adjustment.

Other multi-cylinder engines are similarly calculated, the low pressure mean pressure being simply the mean pressure divided by the number of cylinders. For compound engines with two low pressure cylinders, $M P_2 = \frac{M P \times 2}{3}$ to give equal loads initially and approximately equal powers. For equal temperature ranges in such engines the load and power of each low pressure cylinder is of course only half that of the high pressure cylinder. In other multi-cylinder engines with two low pressure cylinders, the mean pressure multiplied by the number of low pressure cylinders and divided by the total number of cylinders, gives the mean pressure in the low pressure cylinders. In these latter-day engines we cannot combine equal loads, equal powers, and equal temperature ranges with any degree of approximation.

To show the effect of varying the low pressure back pressure in a quadruple cylinder, the following figures are given:—

P_1	P_3	r_1	B_1	B_2	B_3	R.
190	4·	1·33	1	2·0	4·43	11·0
190	6·	1·33	1	1·92	3·93	8·8

A variation of 2 lbs. in the final back pressure, altering the cylinder ratio from 8·8 to 11·0. Small receivers have the effect of increasing cylinder ratios so as to retain equality of temperatures, loads, and powers, especially as to the two former. When a receiver supplies a feed heater, the final cylinders beyond the abstraction point are reduced, while exhaust from auxiliaries has obviously the opposite effect.

The diagram efficiency, E, is the ratio of the actual mean pressure referred to the low pressure cylinder to the calculated, or

$$E = \frac{\text{Actual mean pressure reduced.}}{P_1 \left(\frac{10}{r} - \frac{9}{r^{\frac{10}{9}}} \right) - P_2}$$

where P_1 is the initial and P_2 the final low pressure back pressure, it is desirable to record E as a guide for future estimations for new machines.

An appendix to the paper shows the results for a triple-expansion engine with three cylinders, 150 lbs. pressure absolute, 1·3 expansions in each cylinder, and 4 lbs. back pressure, assuming $r = 9·02$.

Then the results are as follows:—

R.	P_1	$M P_1$.	Relative loads.	Range of temperature.
1·0	15·0	89·366	13·565	70
2·432	55·879	36·677	13·477	67·5
6·938	17·433	12·88	13·433	67·7

The equality of load and temperature range is thus seen to be well secured, while the power in each cylinder or M P × R is also seen to be practically identical.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, *to whom all inquiries should be addressed.*

18,463. "Improvements in electric incandescent lamps and other articles which require to be hermetically sealed." F. J. Satchmell. Dated August 29th.

18,475. "Electric meters." B. J. B. Mills. (T. A. Edison, United States.) Dated August 29th. (*Complete.*)

18,485. "Improvements in the distribution of electrical energy for railways and tramways." J. S. Raworth. Dated August 29th.

18,522. "An improved electrolytic apparatus for the production of alkali." W. Thomson, Baron Kelvin of Largs. Dated August 30th.

18,531. "Improvements in electric railway switches." R. A. Baldwin and H. Rowland. Dated August 30th. (*Complete.*)

18,549. "Improvements in, or relating to, electrically-driven dental engines." O. W. F. Hill. Dated August 30th.

18,566. "An improved electric light fitting." G. Nuttall. Dated August 30th.

18,582. "Improvements in induction motors." R. Belfield. (B. G. Lamme, United States.) Dated August 30th.

18,583. "Improvements in systems for converting the energy of electric currents into mechanical energy by means of induction motors." R. Belfield. (B. G. Lamme, United States.) Dated August 30th.

18,584. "Improvement in controllers for electric motors." H. P. Davis. Dated August 30th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, April 25th, 1898, being date of application in United States.)

18,613. "Improvements in telephonic systems and apparatus." J. E. Kingsbury. (The Western Electric Company, United States.) Dated August 30th.

18,629. "A means of making an electrical contact by pulling a cord or wire." W. W. Martin. Dated August 31st.

18,630. "Improvements in couplings for connecting together the electric wires, as used on railway trains for electrical communication and such like." A. Shiels. Dated August 31st.

18,643. "New or improved apparatus for feeding, or moving forward intermittently, definite lengths of paper textile or other fabric photographic film or other material, in sheet or rolled up form." A. S. Newman and Newman & Guardia. Dated August 31st.

18,649. "Improvements in guide rodes and solenoid cores of arc lamps." J. M. Moffat. Dated August 31st.

18,702. "Improvements in electricity accumulators." A. Schauschieff and A. E. Hodgson. Dated September 1st.

18,722. "Improvements in clips for attaching to telephone or other cables when drawing the same into pipes or conduits." J. G. Brien. Dated September 1st.

18,740. "Improvements in safety fuse apparatus for electrical installations." Siemens Bros. & Co., Limited. (Siemens and Halske, Aktien Gesellschaft, Germany.) Dated September 1st. (*Complete.*)

18,743. "Improvements relating to the extraction of chromium by electrolysis." J. F. L. Moeller and E. A. G. Street. Dated September 1st.

18,750. "An improved coin-freed electric machine." R. Loignion. Dated September 1st.

18,754. "Improvements in electric tramways and railways." J. C. Love. Dated September 1st. (*Complete.*)

18,806. "Improvements in telephonic apparatus." A. Graham. Dated September 2nd.

18,807. "Improvements in electric sparkers for explosive engines." A. Winton. Dated September 2nd. (*Complete.*)

18,820. "Improvements in or relating to electrically illuminated signs or advertisements." G. B. Bowell. Dated September 2nd.

18,847. "Improvements in electric batteries." M. E. Fuld. Dated September 3rd. (*Complete.*)

18,854. "Improvements in electrically igniting charges of internal combustion engines." A. F. Evans. Dated September 3rd.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, *price, post free,* 9*d.* (*in stamps*).

1898.

3,569. "Improvement in electrical apparatus for indicating or recording at a distance positions of an index hand or analogous movable object." A. Custades. Dated February 12th, 1898. This relates to an electrical contact apparatus for indicating or recording at a distance the positions of an index hand. It is comprised of a group of movable contact pieces placed in proximity to the index hand or connected with the distant indicating instrument by separate conductors. A clockwork is adapted to press the contact pieces periodically against the index hand and so close one of the electric circuits which control the distant indicating instrument. 2 claims.

4,435. "Improvements in electric signalling apparatus for use on railways." C. S. Davy. Dated February 22nd, 1898. In advance of each signal post an electric warning bell is provided, suitably supported in proximity to the line, having a circuit so arranged that when a suitable movable contact is operated by the train, the bell will be set in operation if the signal arm is in danger. At the signal post is arranged another electric bell with a different tone to that for stopping the train, so as to notify to the driver that the line is all clear. 3 claims.

4,468. "Improvements in conduits for wires carrying electric current." F. G. Howard and A. W. Sclater. Dated February 23rd, 1898. Straight conduit pieces are formed from strips of rolled sheet metal of sufficient width that when the sides have been turned up the distance between the sides is sufficient to take the required number of wires. Cast angle boxes are used in those places where it is desired to change the direction of the wires. The interiors of the conduit pieces, covers, and angle boxes, are coated with insulating material. 6 claims.